POWER

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New 25,000-Kw. Power Plant for Dayton, Ohio

Station laid out to house 100,000 kw. now has a capacity of 25,000 kw. in two units. Features are economical coal handling, efficient water-softening system, adequate boiler-room instruments and ease of electrical control.

GROWTH in load and the increasing difficulty of getting coal and water in large enough quantities to its two existing plants situated in the business district made it necessary for the Dayton (Ohio) Power and Light Co. to build a new power station. The older plants were rated at 15,000 and 4300 kw. respectively, and as the former had been designed originally for only 4000 kw., it had outgrown the site. The new station was located at Miller's Ford, just below the junction of four streams, so that even during periods of minimum flow there will be plenty of water available for a 100,000-kw. plant. The site is served by the Big Four Railroad and it is only 2½ miles from the load center of the city.

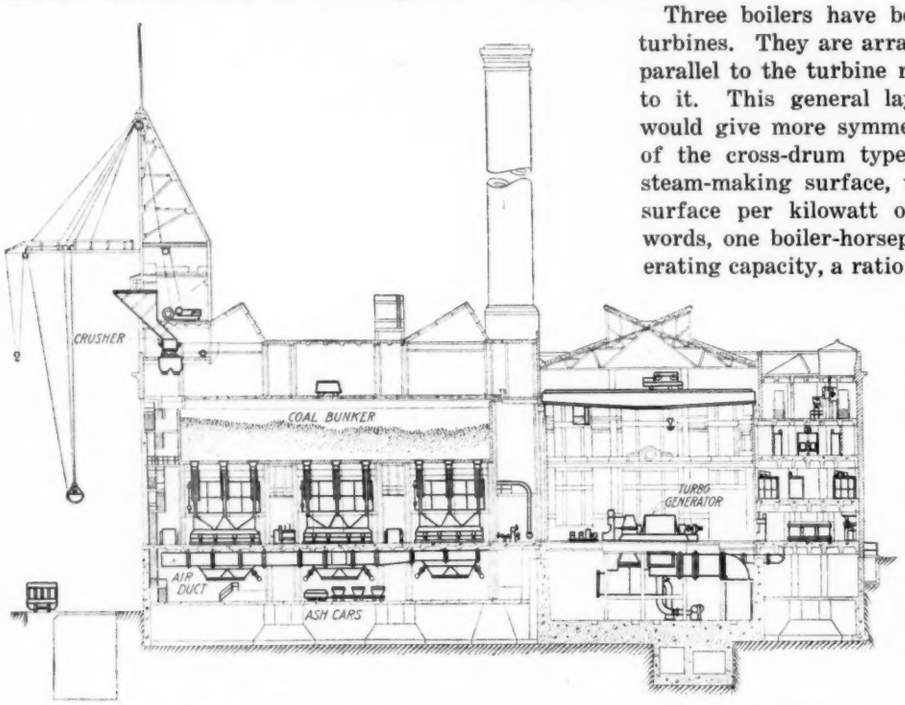


FIG. 1. CROSS-SECTION OF STATION, SHOWING COAL- AND ASH-HANDLING ARRANGEMENTS

Although the ultimate capacity of the station is to be 100,000 kw., the present capacity is 25,000 kw. in two turbo-generator units. The building, measuring 258 ft. long, 117 ft. wide and 95 ft. high from the floor of the condenser pit to the middle of the parapet around the roof, will accommodate about one-half of the ultimate rating of the station. Girders and columns in the superstructure mainly consist of I-beams fastened together with bolts and distance pieces and filled with concrete, this construction being adopted to save steel. With common red-brick walls trimmed with white granite, the exterior of the building has a pleasing appearance. On the inside the station is finished in buff brick except for a 12-ft. wainscoting of salt glazed brick in the turbine room and a finish of white enamel brick in the employees' quarters under the boiler room.

Three boilers have been provided to serve the two turbines. They are arranged in line along a firing aisle parallel to the turbine room instead of at right angles to it. This general layout was selected as one that would give more symmetrical design. The boilers are of the cross-drum type, each having 13,730 sq.ft. of steam-making surface, which reduces to 1.65 sq.ft. of surface per kilowatt of generator rating. In other words, one boiler-horsepower will supply 6 kw. of generating capacity, a ratio exceptionally high unless future provision is to be made for reserve capacity. Each boiler is equipped with a superheater and mechanical soot blowers are installed. Stokers are of the underfeed type, 14 retorts per boiler, with steam-operated dumps. They are driven by a 6 x 7-in. vertical engine or by a 35-hp. induction motor. The driving shaft is installed under the boiler-room floor in front of the stokers, where it is out of the way, but the engine and the motor are both on the boiler-room floor, where they will receive close attention. Arrangements have been made to connect either the engine or the motor to the stoker drive through a variable-speed transmission, the introduction of this device being considered

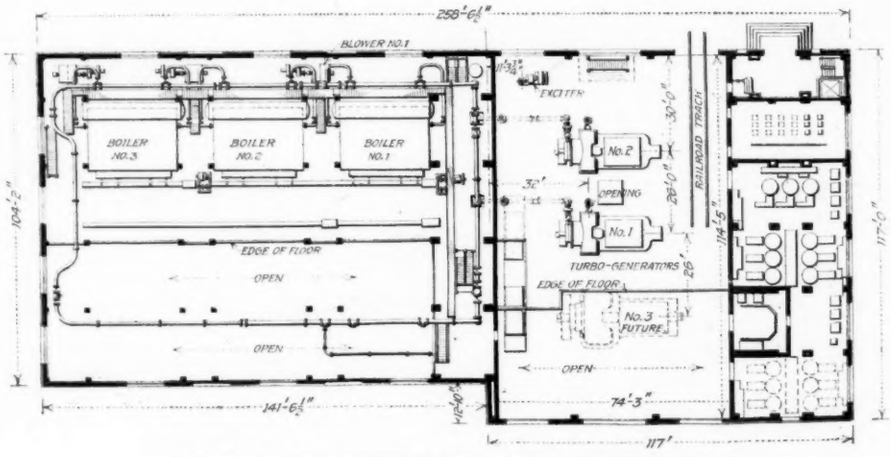


FIG. 2. PLAN OF THE BOILER AND TURBINE ROOMS

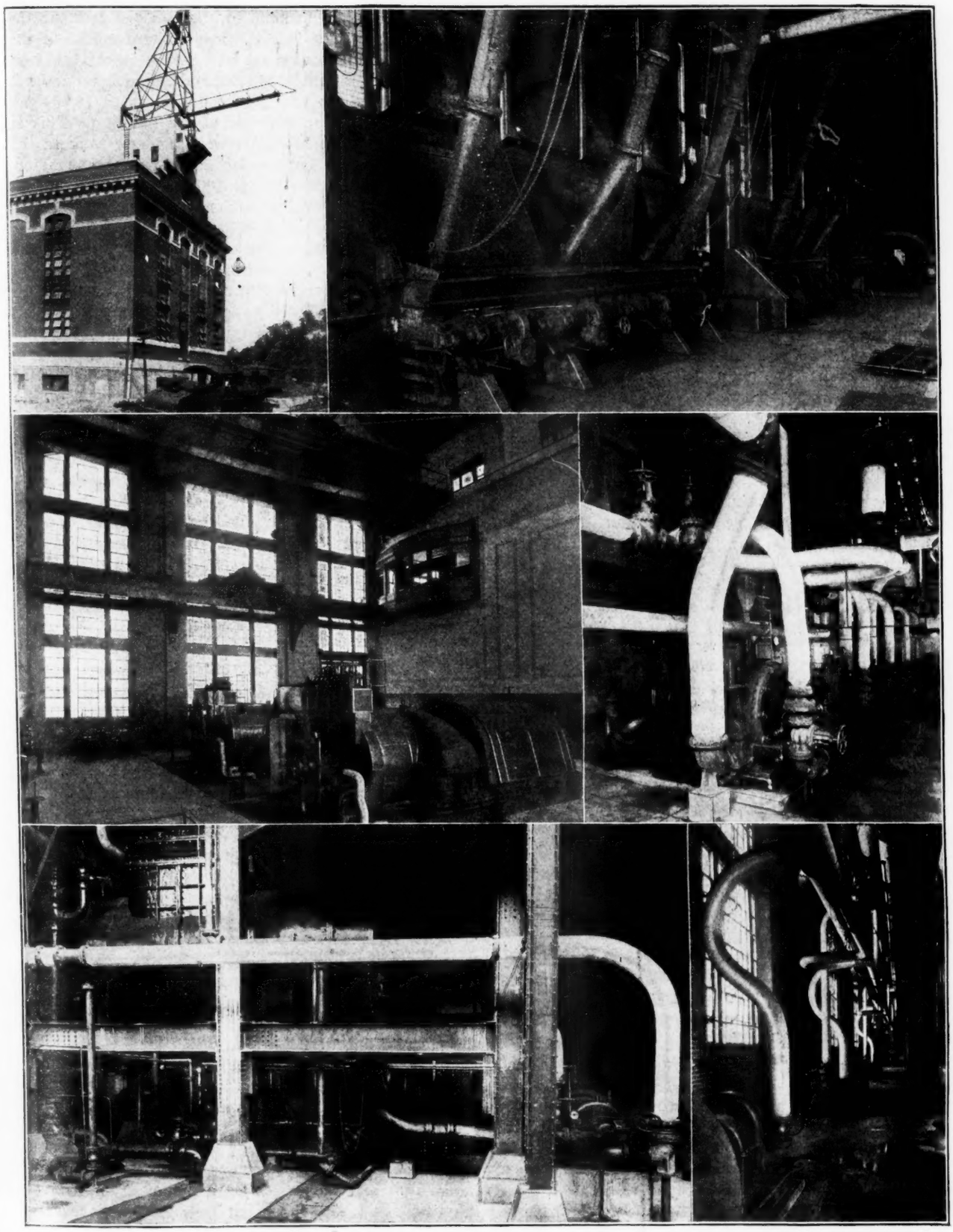


FIG. 3. VIEWS OF NEW DAYTON PLANT, SHOWING PORTIONS OF BOILER AND GENERATOR ROOMS, SOME AUXILIARIES AND CURVED PIPING USED TO ALLOW FOR EXPANSION AND CONTRACTION

advisable, as there is no source of direct current in the plant and variable speed with alternating-current motor drive is required. Under ordinary operating conditions the stokers are driven by the motor and the engine is held in reserve.

For forced draft three multivane blowers, turbine-driven through reduction gearing, have been provided. At maximum rating each fan is guaranteed to deliver 80,000 cu.ft. of air per minute against a 7-in. water pressure. Control of the quantity of air delivered to the furnaces is effected through sensitive air-pressure regulators. From the uptakes of the boilers the gases go through cinder catchers placed between the boilers and the breeching. All passages have been designed so that the velocity of the gases will not be excessive at 300 per cent. rating. The stack is of the self-supporting steel type 16 ft. inside diameter and 300 ft. high above the boiler-room floor.

Each boiler has two main steam outlets with steam-flow meters on each. The header has been arranged on the ring plan with four motor-operated sectionalizing valves that can be controlled from the turbine room or from a point close to the valve. For the most part the piping is above the floor where it is accessible, the leads to the turbines being exceptions. In the boiler room there is an auxiliary steam header and another in the basement of the turbine room for the auxiliaries. All high-pressure drips are collected at a common point and by a direct-acting automatic steam pump fed back to the mud drums of the boilers.

Coal-Handling Apparatus

The coal-handling system consists of a steam hoist operating a clamshell bucket discharging into a hopper above the bunkers. From the hopper the coal passes through a motor-driven crusher into a cable car, where it is weighed before being distributed to the 975-ton brick-lined steel bunker over the boilers. The cable car is electrically operated and is controlled by a man sitting near the scale. The system is rated at 90 tons per hour and is large enough to serve half of the ultimate plant. It resembles closely the coal-handling installation at the Two Hundred and First Street Plant of the United Electric Light and Power Co. at New York, the main difference being that coal at Dayton is delivered by rail instead of by water. If coal is to be used immediately, it is dumped from the railway cars into a concrete coal pocket holding about six carloads. When it is to be placed in storage near the power house, it is unloaded by a locomotive crane. This can also be used to take the coal from storage and dump it into the concrete coal pocket. The scheme was considered best adapted to get the coal up to the station under high-water conditions. Besides, the system is simple and economical to operate and maintain.

From the hoppers under the stokers the ashes are delivered by gravity into side-dump cars, which are hauled out to the low ground around the station by a home-made gasoline-engine-driven tractor. For some time to come the company will use the ashes in filling up the 32 acres of low land around the plant.

The general water supply for the station is obtained from driven wells and the circulating water for the condensers from the river. As the well water is unfit for boiler use without treatment, a hot-process water softener was installed to take care of the makeup, which was estimated to amount to about 2 per cent. of the total water evaporated. To keep down the size of the water-softening equipment and at the same time take care of fluctuations in the demand for makeup and not operate above the rating of the softener, a 10,000-gal. tank was placed on the roof of the building. This is supplied with condensate from a concrete tank in the basement by means of two 100-g.p.m. pumps, one motor- and the other turbine-driven. Their operation is controlled by a float valve in the roof tank. The water from the softener, which is heated to 200 deg. F., goes directly to the heater whenever the water level in the concrete overflow tank for the heater is lowered. This is accomplished by means of a regulator valve installed in the line from the softener to the heater and actuated by the level in the overflow tank. This valve will remain open until the roof tank has been filled and the concrete overflow tank about half filled. The float-controlled valve in the line from the condensate pump to the heater is also operated, causing the condensate to overflow into the concrete tank. The softener is of the Vater type and is capable of treating 3000 gal. of water per hour as it comes from the wells. The water contains about 26 grains of hardness per gallon, which in the softening system is reduced to one grain. General service water is also obtained from driven wells and is pumped to a second roof tank. In an emergency this well water can be used directly for makeup.

There are three turbine-driven boiler-feed pumps, one rated at 1000 gal. per min., and each of the other two at 500 gal. per min., their speeds being 2400 and 2800 r.p.m. respectively. All blowoff water is measured by a V-notch weir as it comes from the blowoff.

Equipment of the Turbine Room

In the turbine room there are now two units rated to deliver 12,500 kw. at 80 per cent. power factor. The turbines are of the 9-stage horizontal impulse type making 1800 r.p.m., and the generators are three-phase 60-cycle 6600-volt machines. At 200 lb. gage pressure, 125 deg. superheat and a vacuum of 29 in., these units are guaranteed to produce a kilowatt-hour at half load on 12.4 lb. of steam. At three-quarter load the rate is 11.95 and at full load, 12.4.

On its former stations the peak load of the company was 21,100 kw., but this does not represent the full height to which the peak would have gone had it not been suppressed last winter. As the generator potential, 6600 volts was chosen, first, because so much of the company's load was already distributed at this pressure, and secondly, because the plant was located such a short distance from the center of the load.

Condensers for the two units are of the two-pass surface type, each containing 15,000 sq.ft. of tube surface, or 1.2 sq.ft. of surface per kilowatt of generator rating. The circulating pumps are mounted on the intake pipe and are driven by a motor at one end of the shaft and a turbine with reduction gearing at the other end. Either drive may be used as dictated by exhaust-steam requirements to maintain the heat balance of the station. Each of the circulating pumps has a capacity of 18,000 gal. per min. The air pumps are of the centrifugal hydraulic type.

Instead of building a long intake extending upstream

to obtain clear circulating water, the company constructed an intake basin by the dragline method, measuring 60 by 330 ft. and about 12 ft. deep. The mouth of the basin points downstream so that the current of the river does not flow into it. This obviates much of the trouble usually encountered from gravel, driftwood and sewage. Another advantage is the shortness of the intake tunnels. From the screen well house situated in this basin the intake tunnel measures 8 x 15 ft. inside, has walls 2½ ft. thick and a floor 4 ft. thick. The intake and discharge tunnels run side by side underneath the turbine room, separated by a 3-ft. wall of concrete. The difference in water temperature in the two tunnels is about 14 deg. The discharge tunnel measures 6 x 17 ft. From the intake tunnel five large cast-iron tubes rise to the water-tight condenser pit. Connection is made to the two circulating pumps now in service, and the other three tubes have cast-iron covers bolted in place.

Excitation at 250 volts is furnished by 170-kw. compound-wound interpole exciters directly mounted on the generator shafts. There is also a 100-kw. independent exciter turbine-driven through reduction gearing, the ratio being 7200 to 900 r.p.m.

A feature of the electrical end of the turbo-generator is that the main leads are brought out through the base of the unit into a terminal chamber above the floor level, so that they are readily accessible. The generator is Y-connected and the neutral is brought out but is not used.

Flexibility of Operation

As shown by the one-line diagram of the electrical connections, the circuits have been arranged to give great flexibility of operation. Each phase lead from the generator consists of two 1,000,000-cir.-mil 10,000-volt cables which are conducted through tile ducts below the floor to the generator oil switch on the first floor of the four-story electrical gallery. From the oil switches the cables go through ducts to the current transformer pits in the floor and thence will go to the middle point of the generator reactors, when these units are later installed. From each end of these reactors they are taken through disconnecting switches, oil switches and a second set of disconnecting switches to the busses on the second floor. In parallel with each generator reactor is another oil switch for tying the ends of the busses together to complete the ring system when the generator is not in operation.

The bus is laid out as a six-section ring with three sections on the north and three on the south side of the station. The feeders are arranged in groups of two which can be connected either to the north bus or to the south bus through a system of feeder group selector oil switches. To facilitate this arrangement the north and south busses are tapped through oil switches to a common point, where connection is made to feeder oil switches and current transformers. From here the leads are taken through three-conductor lead-covered cables to the distribution tower outside of the station. The feeder oil switches and current transformers are on the third floor of the electrical gallery.

Automatic protection is a feature of the feeder layout. This consists of induction-type definite time-limit overload relays and trip free relays, the latter being installed to hold switches in the open position when short-circuits which cause the switches to open originally are still on the line at the time when an attempt is made to reclose the breaker.

The oil switches are all of the remote-controlled type solenoid operated by 250-volt direct current from a 160-amp.-hr. storage battery. All the oil switches except the feeder switches are nonautomatic.

Equipment of the Operating Room

On the third floor of the electrical gallery is the operating room, from which a view of practically the entire turbine room is obtainable. It contains four sections of switchboard arranged on an elongated oval. One section is a seven-panel desk board, another is an eight-panel exciter and generator voltage-regulator board, another is a 10-panel feeder switchboard, the fourth is a three-panel battery, ground detector and instrument board. This layout provides for the ultimate rating of the plant and is complete except for instruments for machines not yet installed.

The generator desk board is made up of six generator panels and one signaling panel. It controls the main-generator oil switches, generator selector oil switches, generator field rheostats, field switches and governor-control motor. Each panel is provided with three ammeters, an indicating kilowatt meter, an indicating wattless component meter, a generator voltmeter, a direct-current field ammeter and a generator-output watt-hour meter. On top of the desk of this board is also laid out a miniature bus with small lamps to indicate for the operator the position of switches on the ring bus.

On the base of the control panel is a set of signal lamps working in conjunction with signal pedestals at the turbines. These bear such signals as "stop," "shutdown," "slow," "fast," "O. K.," etc. The switchboard operator also has manual control of the load sign in the boiler room, which is operated in conjunction with a bell-and-lamp signal each time he changes the setting.

The feeder board controls sixteen feeders, the bus-tie oil switches and feeder-group selector switches. On each feeder is an indicating wattmeter, three ammeters and three type CO induction relays. On the tie lines additional watt-hour meters are installed to check interchange of energy between stations.

The eight-panel exciter board is composed of one generator regulator panel and seven exciter panels. In a room adjacent to the turbine room is another seven-panel auxiliary exciter board on which rheostats and like apparatus are installed to avoid the necessity of carrying heavy direct-current leads to the switchboard room.

On the three-panel battery and instrument board, temperature indicators for all turbines, ground detector lamps for all six busses, a graphic voltmeter and a graphic frequency meter, together with switches and circuits for the storage battery, are installed.

Station light and power are supplied through two banks of transformers, each bank consisting of three 300-kw. delta-connected units used for power purposes and one 200-kw. unit equipped with a low-voltage induction regulator for lighting. Provision has been made for another similar bank of power and light transformers in the ultimate layout. A feature of the station lighting is that an arrangement has been made for

automatically switching over a number of emergency lights at vital points around the station to the storage battery in case of failure of the usual alternating-current supply.

The station was designated by T. E. Murray, consulting engineer, New York. W. Weissinberger, Jr., of New York, was the architect. The operating staff of the Dayton company consists of C. H. Spiehler, engineer of power stations; J. K. Himes, superintendent of the distribution; R. D. Gillespie, chief engineer.

IMPORTANT DATA OF MILLER'S FORD STATION
BOILER ROOM

Type of boiler	B. & W. cross-drum water-tube
Setting	Masonry
Number now installed	3
Steam-making surface, sq.ft.	13730
Steam-making surface installed per kw., sq.ft.	1.65
Pressure for which boilers are designed, lb. gage	225
Operating pressure, lb. gage	200
Superheat, deg. F.	125
Steam temperature, deg. F.	513
Number of tubes per boiler	672
Length of tubes, ft.	18
Diameter of tubes, in.	4
Length of drum, ft.-in.	30-7
Diameter of drum, ft.	5
Stokers per boiler	1
Type of stoker	Taylor
Size of stoker	14 retort
Superheater	B. & W.
Floor space occupied by boiler and stoker	640
Floor space per 10 sq.ft. of heating surface	0.46
Height of boiler from floor to center line of drum, ft.-in.	21-3½
Stack	Brick-lined steel
Stack diameter, ft.	16
Height stack above boiler-room floor, ft.	300
Coal	W. Va. high-volatile
Coal bunker	Brick-lined steel
Capacity bunker, tons	975
Yard storage, tons	100,000
Locomotive crane	McMyler Interstate
Crusher capacity, Mead-Morrison, tons per hour	90
Coal hoist, Mead-Morrison, tons per hour	90
Boiler-feed pumps	3 Platt Centrifugal
Pump capacity, gal. per min.	Two 500 and one 1000
Horsepower of turbine drive	160 and 300
Pump speed, r.p.m.	2800 and 2400
Feed-water heaters	Two Platt Open Type
Heater capacity, lb. per hour	500,000
Service pumps, two; one turbine, one motor-driven, gal. per min. each	300

Turbines

Two General Electric horizontal impulse, kw	12,500
R.p.m.	1,800
Steam pressure, lb. gage	200
Superheat, deg. F.	125
Floor space covered by unit, sq.ft.	415
Floor space per kilowatt, sq.ft.	0.0332

Condenser

Westinghouse two-pass surface, sq.ft.	15,000
Number of tubes	3,043
Size of tubes, in O.D.	1
Surface per kw. gen. rating, sq.ft.	1.2
Circulating pump, Westinghouse centrifugal, gal. per min.	18,000
Speed, r.p.m.	690
Drive, induction motor, turbine, hp.	150
Air pump	Leblanc
Condensate pumps—	
Turbine-driven centrifugal on same shaft with air pump	
Screens	Stationary

Miscellaneous

2 Platt fire pumps, turbine-driven, gal. per min.	500
Drive	Sturtevant turbines
1 Richardson-Phenix oil filter	No. 18
1 Vater water softener, gal. per hour	3000

Generator

Maker, General Electric, kilowatt at 80 per cent. p.f.	12,500
Voltage	6,600
Cycles	60
Phases	3
Field poles	4
Speed, r.p.m	1,800
Exciter mounted on shaft	170 kw., 250 volt
Exciter, turbine-driven, reserve unit, kw.	100
Crane, turbine room, Whiting, tons	75

Electrical

Oil-switch equipment, 6600 volt	Westinghouse
Switchboard	Westinghouse
Lightning arresters	Westinghouse

America's record on the ocean is preëminent. Fulton built the world's first steamboat and thus bridged the seven seas. Never was a project carried out against greater discouragement. He was constantly exposed to sneers and ridicule. Yet it was "Fulton's folly" that paved the way for our modern floating palaces.

Interesting Fuel Tests

In Northern Saskatchewan a number of different fuels are available and in order to determine their relative value a series of tests were conducted at the Prince Albert (Alberta, Sask.) power plant. Bituminous and lignite coals from the neighboring province of Alberta were tested, also jack pine and poplar cordwood, spruce edgings, planing-mill shavings and hog fuel. A hand-fired 72-in. return-tubular boiler 18 ft. long, normal rating 150 hp., was used for the coal and wood tests. The grates used were half-inch herringbone pattern, having a total grate area of 36 sq.ft. with air spaces forming approximately 45 per cent. of the total area.

The six-hour tests of some of the lignites were run through without any necessity for cleaning fires, but no attempt was made to work the boiler much beyond 80 per cent. of its rated capacity. In other cases and with all the lignite slacks it was found advisable to clean fires about every two and one-half hours, otherwise the rate of evaporation decreased rapidly. Some of the samples proved superior to others in this respect, the clinker formed being so light and porous as not to seriously impede the draft until a considerable thickness had accumulated. A fuel bed about 4 in. in thickness was found most suitable, and the best results were obtained when the clinker was left undisturbed, no slice bar being used. The use of the bar seemed to increase the amount of clinker, even when the greatest care was exercised, and much red-hot coal would fall into the ashpit where it continued to burn until consumed; thus very little of this waste could be discovered by the examination of the ash pile. When the clinker was left undisturbed no coal fell into the ashpit except for a short time after cleaning fires. With most samples the fire never appeared intensely hot and showed the characteristic blue flame of CO. It will thus be seen that these could appear to be similar in behavior to the North Dakota lignites described recently in *Power*. The following results seem to show that the size of the coal is an important factor:

Size of Coal	Equiv. Evap. Lb.	Per Cent. of Ash and Clinker
Screened nut	5.3	8.5
Slack	4.0	16.0
Screened nut	6.6	8.0
Slack	3.9	11.0

The extra moisture in the slacks was no doubt partly responsible for the difference, but the chief trouble seemed to be the difficulty in effecting the proper mixture of air with the fuel, the slacks while burning resembling red-hot sand. Most of the samples of nut or egg size, when exposed to the weather in piles of a few tons, disintegrated in the course of a few months, and in this state their behavior in the fire seemed even less satisfactory than slack from the mines, though no evaporation tests were made. The effect of firing the lignites on different well-known standard grates with air spaces approximately 40 to 45 per cent. of the total area was also observed. Types of grates used were as follows: ¾-in. air space straight-slot fire bars; ⅝-in. air space straight-slot fire bars; ¼-in. air space diagonal-slot grates and sawdust grates with holes ¼ in. in diameter having an approximate total air space of 10 per cent. of the full grate area. However, the ½-in. her-

ringbone type of grate previously mentioned proved to be the most satisfactory.

When burning slack under forced draft the required rate of evaporation could be kept up for a much longer period, but the removal of clinker became a Herculean labor. The amount of water evaporated per pound of coal was about 4 per cent. higher than with natural draft. The fire was started under natural draft and after a sufficient thickness had accumulated on the grates the fan was started slowly and gradually speeded up as found necessary. This had to be done very carefully or the fire soon resembled a number of miniature volcanoes.

Different samples of lignite in the nut and egg sizes showed equivalent evaporation of from 4.6 to 6.6 lb. of water per pound of coal as fired, and the percentage of ash ranged from 8 to 20. With slack and pea coal the results from different samples were an equivalent evaporation of from 4 to 5.7 lb. per pound of coal, the percentage of ash being 11 to 24.

Result of Tests with Coal and Wood

For many years wood was the cheapest and most abundant fuel in this district and was used almost exclusively for both heating and steam raising. Jack pine and poplar cordwood and spruce edgings (in bundles about 6 in. in diameter) were all used as fuel. In the tests the same herringbone grates were used as for coal, but the ends next the bridge-wall for a distance of 18 in. were covered with sheet iron protected by a layer of ashes. A poker was used occasionally to consolidate the fuel and the furnace was kept as full as possible. The results obtained compared with two different coals are shown in Table I. The jack pine and poplar were cut green, split and seasoned in piles for over twelve months, and the edgings were thoroughly air-dried for a similar period. With all the woods the rate of evaporation was steadily maintained throughout the tests. Note the low draft readings. With poplar the gage did not move appreciably although graduated

TABLE I. RESULTS OF SIX-HOUR TESTS

	Bituminous Slack	Lignite 50 Per Cent. Nut 50 Per Cent. Slack	Jack Pine Cordwood	Poplar Cordwood	Spruce Edgings
Duration of test, hr	6	6	6	6	6
Gage pressure, lb	125	125	125	125	125
Average temperature feed water, deg. F	177	179	180	180	178
Average temperature flue gases, deg. F	490	495	500	485	490
Thickness of fire, in	9	4	24	24	24
Draft, in	0.12 to 0.19	0.04 to 0.27	0.01 to 0.02	.....	0.00 to 0.01
Total water evaporation, lb	24,200	22,800	23,600	24,000	24,400
Total fuel fired, cords of 128 cu.ft	2,600	4,100	5,565	6,830	8,022
	.....	.....	2.1	2.75	3.6
Total weight ash and clinker, lb	314	374	37	57	108
Per cent. ash and clinker	12	9	0.65	0.85	1.35
Water evap. per lb. of fuel as fired, lb	9.3	5.6	4.3	3.5	3.0
Equivalent evaporation from and at 212 deg. F. per lb. of fuel	10.0	6.0	4.6	3.8	3.3
Equivalent evaporation from and at 212 deg. F. per cord of 128 cu.ft	.....	.....	12,100	9,400	7,300

to 0.01 in. A much higher rate of evaporation could have been obtained and in actual service actually was maintained. The quantity of ash with wood is very low; it was the custom to clean out the ashpit weekly. The grates, of course, did not require cleaning. The bituminous slack designated in the table was a coking coal. With proper slicing and raking very little clinker formed with this coal and a very high rate of evaporation could be maintained for several hours. The lignite, 50 per cent. nut and 50 per cent. slack, was from the Drumheller coal field and was one of the best samples tested. It ignited readily, seemed to contain less moisture than most of the other slacks and burned with a brighter flame.

Shavings and Hog Chips as Fuel

From May 15 to about Oct. 15, planing-mill shavings and spruce hog chips from a local sawmill are burned. Two 300-hp. B. & W. boilers fitted with dutch-oven furnaces are used, the fuel being fed to the furnaces by a chain conveyor and chutes. The grate area is 63 sq.ft. The shavings used in the test were comparatively dry, the lumber having been piled and seasoned for some time. The hog fuel was very wet, as the logs are floated down the river to the mill. The results of the tests are given in Table II. As a basis of comparison hand-fired tests were also made under the same boilers used with the bituminous and lignite tests shown in Table I. A gain in equivalent evaporation of about 7 per cent. was obtained in both cases.

TABLE II. RESULTS OF SECOND SERIES OF TESTS

	Bituminous Slack	Lignite 50 Per Cent. Nut 50 Per Cent. Slack	Planing Mill Shavings	Hog Fuel
Duration of test, hr	5	5	8	5
Gage pressure, lb	125	125	125	125
Average temperatur feed water, deg. F.	180	181	180	188
Average temperature flue gases, deg. F.	480	500	492	495
Total water evaporation, lb	36,800	37,200	56,400	37,600
Total fuel fired, lb	3,700	6,214	.....	.....
Total fuel fired, cords of 128 cu.ft	.....	.....	12	8
Equivalent evaporation from and at 212 deg. F. per lb. of fuel as fired	10.7	6.4	.....	.....
Equivalent evaporation from and at 212 deg. F. per cord of 128 cu.ft	.....	.....	5,062	5,062

In conclusion it may be of interest to note that, contrary to the opinion of people who are accustomed to burning coal, the firemen here, being experienced in handling cordwood, claim that it is much easier work than firing coal.

Duty in Steam-Pipe Fitting

One who undertakes to install steam pipes upon the premises of another is liable for injury resulting from his negligent failure to make proper inspection and tighten loose bolts before turning steam pressure on, holds the Appellate Term of the New York Supreme Court in the recent case of Charles G. Robin, Inc. vs. New York Steam Co., 171 New York Supplement, 55.

Plaintiff sued the owner of a building in which the former subleased quarters, and the steam company to recover damages caused by giving way of a steam valve on the premises, and escape of steam which injured plaintiff's goods. Pipes to heat the premises had been installed by an independent contractor acting under agreement with the owner, and the steam company turned on pressure.

The court holds that the owner of the premises is not liable, since the accident resulted from omission of the contractor to have two flanges of pipes at a point of connection properly bolted together. But it is decided that either or both the contractor and the steam company are liable for any negligence on their respective parts. The former's liability is rested on omission of his employees to properly tighten the bolts, and the latter's responsibility rests on omission of its employees to take reasonable steps to ascertain that the new pipes would safely carry steam pressure.

Why You Should Insulate That Bare Pipe

By CHARLES H. BROMLEY

HOW many square feet of steam and hot-water piping in your plant are uncovered? Would it not be worth while to go around the plant with notebook and pencil and jot down the location, size and length of bare pipe? Yes, it would; and the following will surely convince you that it will be worth while:

How much heat does a square foot of bare steam pipe radiate (waste) when the pressure is say, 100 lb. and the room temperature is 70 deg.? Roughly, 1200 B.t.u. per hour. For 200 lb. pressure 1400 B.t.u. per hour.

Let us get a better idea of how much heat 1400 B.t.u. represents:

It is nearly as much heat as is in 1½ lb. of exhaust steam at atmospheric pressure.

It will raise the temperature of nearly 10 lb. of feed water from 70 deg. to 210 deg. F. For every 11 deg. that feed water is heated by waste heat, as exhaust steam, a saving of 1 per cent. on coal is effected.

It is the equivalent of nearly half a kilowatt.

For a 24-hour day it about equals a boiler-horsepower-hour.

It equals the heating value of $\frac{1}{10}$ lb. of good coal.

Wasted every day for a month from 28 sq.ft. of pipe it wastes more coal than would make twenty-five 3-in. shells for our boys in France.

Radiating (wasting) from 28 lin.ft. of 3-in. bare pipe, it equals the heating value of a ton of excellent coal, or say $8 every month—enough to pay for a $100 Liberty Bond in three months at $8 a week.

With coal at this price 28 ft. of bare 3-in. pipe, or 28 sq.ft. of uncovered pipe of any diameter, wastes in a year as much money as would buy enough good magnesia covering to cover it four-and-a-half times.

Figure it out yourself. Here are the prices of good magnesia covering:

PRICES OF MAGNESIA PIPE COVERINGS

Inside Diameter of Pipe, In.	Thickness of Standard Covering, In.	Price per Lineal Foot Canvas Jacketed	Thickness of Covering, In.	Price per Lineal Foot Canvas Jacketed	Thickness of Covering, In.	Price per Lineal Foot Canvas Jacketed	Double Layer Double Standard Thickness, In.	Price per Lineal Foot Canvas Jacketed	Double Layer Total Thickness 3 In., In.	Price per Lineal Foot Canvas Jacketed
¼	1	$0.22	1½	$0.46	2	$0.75	1½	$0.65	3	$1.20
½	1	.24	1½	.49	2	.80	1½	.70	3	1.35
1	1	.27	1½	.52	2	.85	1½	.75	3	1.40
1¼	1	.30	1½	.56	2	.90	1½	.80	3	1.45
1½	1	.33	1½	.60	2	.95	1½	.85	3	1.55
2	1	.36	1½	.64	2	1.00	1½	.90	3	1.65
2½	1	.40	1½	.70	2	1.05	2	1.00	3	1.75
3	1	.45	1½	.76	2	1.15	2	1.10	3	1.90
3½	1	.50	1½	.82	2	1.25	2	1.20	3	2.05
4	1	.60	1½	.88	2	1.35	2	1.40	3	2.20
4½	1	.65	1½	.94	2	1.45	2	1.50	3	2.35
5	1	.70	1½	1.00	2	1.55	2	1.60	3	2.50
6	1	.80	1½	1.10	2	1.70	2	1.80	3	2.70
7	1	1.00	1½	1.20	2	1.85	2	2.25	3	2.90
8	1	1.10	1½	1.35	2	2.00	2	2.50	3	3.15
9	1	1.20	1½	1.50	2	2.20	2	2.70	3	3.40
10	1	1.30	1½	1.65	2	2.40	2	2.90	3	3.65
*12	1	1.85	1½	1.85	2	2.70	3	4.10	3	4.10
14	1	2.10	1½	2.10	2	3.00	3	4.60	3	4.60
16	1	2.35	1½	2.35	2	3.30	3	5.10	3	5.10
18	1	2.60	1½	2.60	2	3.60	3	5.60	3	5.60
20	1	2.85	1½	2.85	2	4.00	3	6.00	3	6.00
24	1	3.30	1½	3.30	2	4.50	3	7.00	3	7.00
30	1	4.00	1½	4.00	2	5.50	3	8.40	3	8.40

* All coverings larger than 10 in. furnished in segment form; jackets and bands not included.

A square foot of ordinary bare pipe will radiate 3 B.t.u. per square foot per hour per degree difference between the temperature of the pipe and the outside or room temperature. A well-covered steam pipe will radiate only about 0.3 to 0.4 B.t.u. per square foot per hour per degree difference between the pipe temperature and the room temperature. Bare steam pipes carrying pressures commonly used in power plants have temperatures as given in the following table:

TEMPERATURE OF BARE STEAM PIPES CARRYING SATURATED STEAM AT VARIOUS PRESSURES.

Steam Pressure	Temperature of Surface of Pipe, Deg. F.	Steam Pressure	Temperature of Surface of Pipe, Deg. F.
10 in. vacuum	192.23	5	228
8 in. vacuum	196.73	6	230
6 in. vacuum	200.94	7	233
5 in. vacuum	202.92	8	235
2 in. vacuum	208.52	9	237
1 in. vacuum	210.28	10	240
		80	324
Lb. per Sq. In. Gage		100	338
0	212.0	150	366
1	216.	160	370
2	219.	180	380
3	222.	200	388
4	225.		

Here is a table giving the lengths of pipes of various sizes per square foot of outside surface of the pipes:

Pipe Size, Diameter, In.	Length of Pipe in Ft. per Sq. Ft. of External Surface	Length of Pipe in Inches per Sq. Ft. of External Surface	Pipe Size, Diameter, In.	Length of Pipe in Ft. per Sq. Ft. of External Surface	Length of Pipe in Inches per Sq. Ft. of External Surface
1	2.9	34 11/32	5	0.68	8 3/16
1¼	2.3	27 5/8	6	0.57	6 27/32
1½	2.0	24	7	0.50	6
2	1.6	19 7/32	8	0.44	5 9/32
2½	1.3	15 5/8	9	0.39	4 11/32
3	1.0	12	10	0.35	4 3/16
3½	0.95	11 13/32	12	0.29	3½
4	0.84	10 3/32	14	0.25	3
4½	0.76	9 1/4	15	0.23	2 25/32

The coal losses as given in this article are conservative; they do not include the losses that occur in getting the heat to the pipe. But the more it costs to get the heat to the pipe the greater will be the loss in coal for heat lost on account of uncovered pipe.

And do not forget that the Fuel Administration is on the lookout for uncovered steam pipe.

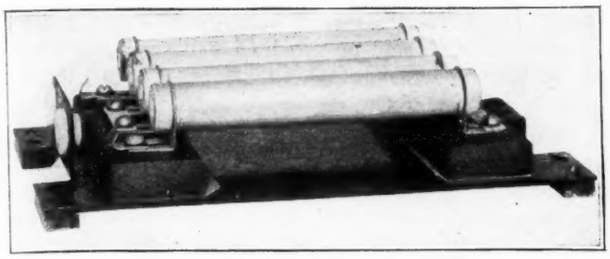
If the Administration's inspectors have not already found the uncovered pipe in your plant, it will be to your advantage to see that they find none when they do arrive.

Enameled Resistance Units for Current Regulation

Enameled resistance units for regulating current have been developed in various forms and sizes by the General Electric Co., Schenectady, N. Y. Some of the applications to which these units have been put are railway and fire-alarm signals, fractional-horsepower motors and locomotive headlights. They are also used extensively in series with relay, contactor and circuit-breaker coils on panels and switchboards. They are particularly applicable in mines and similar places where dampness and moisture are present. These units (see illustration) are capable of withstanding unusually high temperatures as well as sudden changes in temperature from one extreme to the other.

The resistance wire or conductor is wound either upon a steel body coated with a special refractory enamel or paint and high-heat resisting silicate compound developed to withstand sudden extreme temperature changes without cracking or weakening or in any

way being injured. The steel body is preferred for extreme lengths where strength for a long span is required and is especially serviceable where the unit might be subjected to severe vibration or shock. The refractory-silicate body is used for most of the ordinary types of resistance.



ENAMELED RESISTANCE UNITS

After being wound upon the proper body the conductor is embedded in a blue vitreous enamel and is fused, until it has a uniform glossy structure, at a temperature of about 1000 deg. C. This enamel is moisture- and heat-resisting and forms a mechanically strong casing for the conductor.

Several different methods of attachment to the circuit have been developed. A variety of units of various sizes and ohmic capacities have been standardized, and units of a special nature are obtainable.

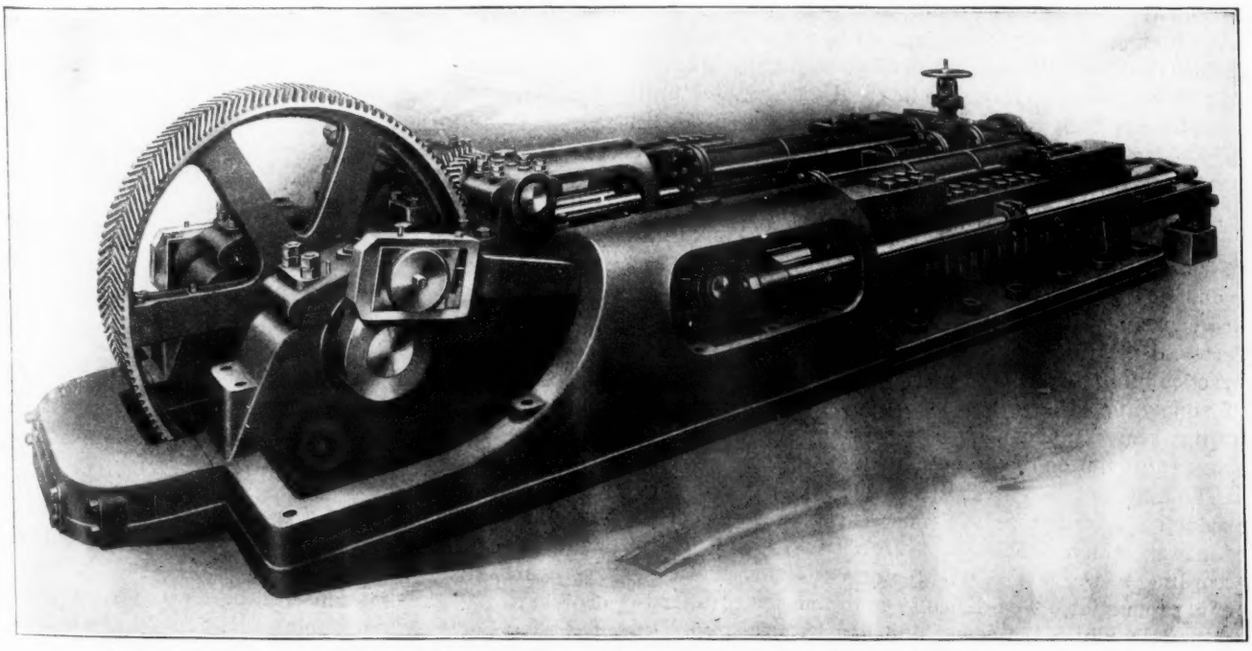
New Design of Oil-Line Pump

The last three years have seen a marked development in hydraulic pumps. Sizes have increased, designs have been simplified, and forged cylinders have come into use for pressures above 1000 lb. per sq.in. The Worthington Pump and Machinery Corporation, 115 Broadway, New York City, recognized the possibilities of this construction for oil-line work where the pressures run from 700 to 1000 lb. A number of trial installations were secured, their success has been demonstrated, and their design is now used on pumps from 4 x 12 duplex, 4000 bbl. per day, up to 6½ x 24 duplex, 20,000 bbl. per day, and can be furnished for larger capacities.

There are in this construction a number of features that appeal to the operators. Broken cylinders and valve pots are avoided. The use of gaskets on the pressure joints is not required, for the joints are of small size and special form which permits making them tight metal to metal. Heavy valve-pot covers do not have to be lifted to get at the valves. Each valve has its individual cover in the form of a screwed plug (see the illustration). There are no studs to break off in making up pressure joints when handled by rough inexperienced labor. Every part of the pump is readily accessible to a man standing on the floor. It is built low down, close to the foundation, by which it is rigidly supported. These features are shown in the accompanying view of the pump.

The valves are solid bronze balls or bronze wing-guided type with or without leather faces, according to the requirements of the service. While the valves are all accessible from the top of the cylinders, the suction valves are below and the discharge valves above the plungers. This allows a reasonably direct flow through the pump without an abrupt reversal of direction. The location of the valves permits of a minimum-sized pulsation chamber, thus reducing the clearance, an important feature in handling volatile fluids. A further advantage due to the position of the valves is a reduction of several feet in the suction lift, thus allowing the supply tanks to be drawn down to a lower level.

Heavy frames supported throughout their whole length directly on the foundation give strength and rigidity. All bearings and pins are of liberal size and are provided with readily taken-up adjustments. Gearing of either the spur or herringbone type is made of suitable ratio for direct connection to an oil engine when so desired.



WORTHINGTON OIL-LINE PUMP WITH FORGED CYLINDERS

Power Consumption of National Industries

By L. W. SCHMIDT

An attempt is made by the author to evolve a scheme according to which the power requirements of the leading national industries should be measured with a view to facilitating regional distribution and to prevent waste. A statistical table accompanies the article.

DURING the year 1914, in which the war started, American industry was using 22,547,574 hp. in the form of primary power, and it spent the enormous sum of $666,406,709 for fuel and rent of power. It must be suspected that much of that power might have been saved. Now the necessity for saving has come. The Fuel Administration has cautioned industry against a wasteful use of power. It has pointed out that there is enough fuel to last us through any emergency, but there is no doubt that it is today a patriotic duty not to waste fuel. When the electric lighting of shops is curtailed and hints are thrown out that it may become necessary to cut in two the power allotment of the private citizen, the time has arrived when the industrial-power consumer should check his power consumption and see whether he is not using too much.

Bulk of Power Produced by Private Plants

Power is produced by two different agencies. The first and most active of these is private generation by steam, water, or internal-combustion engines. Of the 22 million primary horsepower employed by industry during the year 1914, over 18,500,000 hp., or 82 per cent., was produced in this way. The remainder consisted of power rented by the consumers; and 3,917,655 hp. of rented power was electrical and was supplied presumably by central stations.

Unfortunately, our knowledge as to what should constitute the normal consumption of power in any industry is still very small. Industry in the United States until recently has been very little troubled with the necessity of looking out for the saving of cents. Everything has been handled on a large scale, and with the wealth of the country rapidly growing the loss of a few paltry horsepower has not been considered vital. Estimates as to what constitutes a safe limit of power for certain industries have not been made yet. As a result, there are enormous differences in the power consumption of factories making identical products and working under practically similar conditions. It is with the intention of supplying a basis for such estimates that the following remarks and a statistical table of the average power consumption of our national industries are offered.

The table is based on the principle that every factory producing a certain article must use a given quantity of power which should be uniform in every locality according to the size of the factory and the character of its production. The difficulty is to find a corresponding unit by which the power unit can be measured. In this instance man power is used for that purpose. Whatever may be the character of the machinery employed, there must go with every machine a certain complement of human labor which will remain approximately the same through the industry. A shoe factory is built to produce a certain quantity of boots and shoes by employing a certain quantity of labor, which means that if one hundred men are to be employed, a corresponding floor space must be allowed for each employee, and there must be installed sufficient machinery. Each machine in turn requires the attendance of a certain number of men. The number of employees, therefore, forms the safest unit for measuring the power requirements of a factory.

Table Based on Figures of Last Census

The figures used in this experiment are those of the census of 1914, which year is the last when conditions in national industry were approaching the normal, and it is, of course, normal conditions that must be dealt with. The results of the research are in no way affected thereby, as any changes that have taken place since 1914 in the employment of labor in individual industries cannot affect much the proportional power requirements of each.

The first column of the statistical table contains the number of hands employed in each of the represented industries during the year of the last census. This is the unit of man power. The second column shows the primary horsepower for each industry, the third all electrical power used, and the fourth that part of the electrical power consumed by the industry which is not produced by the consumer but rented from some other source, presumably a central station. In the fifth column the average primary power per employee in each industry is given. As will be seen, this varies a good deal in the different industries. The greatest amount of power in proportion to human power is employed in the blast furnaces of the iron and steel industry, in which 41.6 hp. is needed for each employed man. Other industries using a large quantity of power per employee are the flour mills with a national average of 20.7 hp., the ice industry with an average of 20 hp., the cement industry with 17.5 hp., the paper industry with 18.3 hp., and the rolling mills of the iron and steel industry with 10.9 hp. The smallest user of power per employee is the turpentine industry, which consumes only 0.07 horsepower.

National Average Frequently Exceeded

The power economist will argue with some reason that this national average of power consumption most certainly is exceeded in many instances and that consequently there must be many factories that run with a power consumption much below the national average. Except in unusual cases, therefore, a factory running with a power consumption approaching the national average of its industry is not doing anything extraordinary. It does not conserve power and most likely it does not even run economically. In fact, wherever an experiment shows that the factory requires for its

operation a power development the same as the national average, or at least approaching it, there seems to be cause for an overhauling of the power facilities with a view to finding out whether savings can be made by changing the installation. Today, when the increasing power requirements of local industries are a source of much trouble to central station men, it may very well pay to inquire whether savings cannot be made in another. As shown in the sixth and seventh columns of the statistical table, the extent of this use varies a good deal according to the industry. In this respect the cement industry leads the country as an employer of electrical energy, consuming 12 hp. per man. Next in importance follows the iron industry, consuming 7.2 hp. per head. Other important consumers are the chemical industry with 5.3 hp., the rolling mills of the

HORSEPOWER USED PER WAGE EARNER IN VARIOUS INDUSTRIES DURING 1914

	Number of Wage Earners	Total Primary Power, Hp.	Electrical Power Total Hp.	Electrical Power Rented Hp.	Total Power per Wage Earner Primary Hp.	Total Power per Wage Earner Electrical Hp.	Ratio of Electrical to Primary Power, Per Cent.	Ratio of Electrical Power Rented, Per Cent.	Horsepower per $1,000 of Product
Agricultural implements	48,459	121,428	83,117	30,764	2.5	1.7	68	37	0.73
Artificial stone products	10,255	20,326	6,472	6,053	1.9	0.6	31	93	0.92
Automobiles and bodies	127,092	173,684	135,818	102,156	1.4	1.0	78	75	0.26
Boots and shoes, including cut stock and findings	206,088	112,929	61,657	37,389	0.5	0.3	54	60	0.19
Boots and shoes from rubber	18,687	24,621	6,607	3,381	1.3	0.3	28	51	0.45
Boxes (fancy and paper)	45,311	38,179	22,722	14,918	0.8	0.5	59	65	0.51
Brass, bronze and copper products	40,306	122,700	64,868	31,673	3.0	1.6	52	48	0.75
Bread, bakery	124,052	107,771	86,779	68,933	0.9	0.6	80	79	0.21
Brick, tiles and pottery	127,444	470,758	95,080	68,638	3.7	0.7	20	72	2.53
Butter, cheese, and condensed milk	23,059	130,862	23,061	17,027	5.7	1.0	17	73	0.35
Buttons	14,511	14,398	5,016	3,951	1.0	0.3	34	79	0.69
Canning and preserving	74,071	120,004	28,438	18,726	1.6	0.4	23	66	0.79
Carpets and rugs	31,309	29,486	25,251	9,159	0.9	0.8	85	36	0.42
Carriages and wagons	52,391	112,549	46,384	32,651	2.1	0.9	41	70	0.78
Cars and general shop construction (electric railroads)	26,384	44,989	44,670	36,861	1.7	1.7	99	82	1.16
Cars and general shop construction (steam railroads)	339,518	433,994	325,054	102,562	1.3	0.9	75	31	0.82
Cars, steam railroad, not included above	54,288	126,687	115,479	20,416	2.3	2.1	91	17	0.65
Cement	27,916	490,402	336,516	164,369	17.5	12.0	68	49	4.81
Chemicals	32,311	282,385	172,510	134,481	8.7	5.3	61	77	1.52
Clocks and watches	23,328	15,647	8,844	3,063	0.6	0.4	56	34	0.48
Clothing, men's	225,719	53,281	33,444	28,284	0.2	0.1	62	82	0.11
Clothing, women's	168,907	28,396	24,757	24,029	0.2	0.1	87	97	0.05
Coke, not including gas-house coke	21,107	120,327	88,409	37,640	5.7	4.2	73	42	1.21
Confectionery	53,658	55,823	36,941	19,282	1.0	0.7	66	52	0.32
Copper and tinsheeting	80,029	75,263	49,473	30,644	0.9	0.6	65	61	0.79
Cordage and twine	27,326	93,937	34,098	10,649	3.4	1.2	36	31	1.57
Corsets	20,496	7,057	4,273	2,273	0.3	0.2	60	53	0.17
Cotton goods	393,404	1,585,953	512,903	252,864	4.0	1.3	33	49	2.29
Cutlery and tools	33,427	73,255	34,680	17,586	2.2	1.0	47	50	2.86
Dyeing and finishing	48,467	130,172	51,021	7,162	2.7	1.0	39	14	1.19
Fancy articles	10,967	8,005	3,240	3,075	0.7	0.2	40	95	0.45
Fertilizers	22,815	114,281	65,266	47,450	5.0	2.8	57	72	0.74
Firearms and ammunition	18,557	18,828	17,259	4,951	1.0	0.9	91	28	0.45
Flour mills and grist mills	39,718	822,384	150,248	112,441	20.7	3.7	18	74	0.93
Food preparations	20,306	80,022	47,761	34,347	3.9	2.3	59	71	0.36
Foundry and machine-shop products	564,610	1,129,768	896,849	444,328	2.0	1.5	79	49	0.82
Furniture and refrigerators	133,498	251,997	88,964	48,597	1.9	0.6	35	54	0.89
Gas illuminating	43,792	245,715	38,826	19,271	5.6	0.9	15	49	1.11
Glass	74,502	163,139	92,896	14,224	2.1	1.2	56	15	1.33
Gloves, leather	10,668	3,357	1,515	1,277	0.3	0.1	45	83	1.15
Hats	21,318	20,851	8,141	2,655	0.9	0.4	39	32	0.55
Hosiery, knit goods	150,520	125,842	46,117	26,284	0.8	0.3	36	56	0.48
Ice	23,011	461,988	50,546	28,991	20.0	2.2	11	57	7.64
Iron and steel, blast furnaces	29,356	1,222,273	212,582	21,601	41.6	7.2	2	10	3.84
Iron and steel, rolling mills	248,716	2,706,553	1,207,715	182,209	10.9	4.8	45	15	2.94
Iron and steel, bolts and nuts	10,658	28,897	18,562	13,651	2.7	1.7	64	73	1.23
Iron and steel, forgings	10,689	38,215	25,076	17,048	3.5	2.3	65	67	1.31
Jewelry	28,289	15,666	11,392	10,433	0.5	0.4	73	91	1.19
Leather, tanned	55,456	122,712	73,424	21,570	2.2	1.3	60	29	0.47
Lime	12,429	39,134	12,851	11,253	3.1	1.0	32	87	2.12
Lumber products	618,163	2,796,902	305,540	149,152	4.5	0.5	11	48	2.78
Marble and stone	54,981	207,461	94,976	66,997	3.7	1.7	45	70	1.93
Mattresses	11,747	21,674	15,412	14,363	1.8	1.3	71	93	0.55
Millinery	45,274	12,736	7,883	6,563	0.3	0.1	61	83	0.11
Mineral waters	15,506	25,164	11,883	11,001	1.6	0.7	47	93	0.43
Musical instruments	37,556	44,349	21,492	9,046	1.2	0.5	48	42	0.47
Oil, cottonseed cake	21,810	249,781	30,893	23,126	11.5	1.4	12	74	1.17
Paint and varnish	16,083	70,611	34,917	19,035	4.4	2.2	49	54	0.48
Paper, wood pulp	88,457	1,621,154	325,211	127,669	18.3	3.6	20	39	4.88
Patent medicines	25,502	28,872	17,924	10,422	1.1	0.7	62	58	0.28
Paving materials	19,540	138,026	52,819	46,604	7.1	2.7	38	88	3.58
Petroleum	25,366	128,468	38,614	14,353	5.1	1.5	30	37	0.32
Rubber goods	50,220	151,927	93,998	25,664	3.0	1.8	61	27	0.67
Sewing machines	18,007	24,229	19,378	2,434	1.3	1.0	80	12	0.88
Shipbuilding	44,489	115,333	66,275	30,085	2.6	1.4	57	45	1.30
Silk goods	108,170	116,924	47,401	23,748	1.0	0.4	40	50	0.46
Slaughtering	101,076	260,996	122,956	44,059	2.6	1.2	47	36	0.15
Smelting and refining copper	17,731	194,980	88,213	36,620	10.9	4.9	45	41	0.44
Soap	14,172	35,737	16,960	4,014	2.5	1.2	47	23	0.27
Stoves and furnaces	37,325	49,150	30,843	18,506	1.3	0.8	62	60	0.54
Sugar refining	11,253	49,666	24,016	4,190	4.4	2.1	48	17	0.17
Tobacco	178,872	38,737	21,555	11,766	0.2	0.1	55	54	0.07
Turpentine	34,817	2,478	2	.....	0.07	0.0	0.0	0.0	0.11
Typewriters	11,091	10,887	7,347	1,803	0.9	0.6	67	24	0.44
Wire	17,600	83,940	39,458	16,463	4.8	2.2	46	42	1.02
Wire work	12,126	21,547	14,305	10,391	1.7	1.1	66	73	0.51
Wood	11,615	43,334	4,330	3,162	3.7	0.4	10	73	2.27
Woolen goods	163,976	398,367	144,244	25,047	2.4	0.8	36	17	1.01

the power requirements of the individual power consumer with a view to accommodating additional consumers without unduly increasing the load carried by the central station. Such an investigation also may prove of value to all power engineers who are put to keeping down the coal bill.

There is today in the United States no industry that does not make use of electrical power in one way or iron industry with 4.8 hp., and the flour-mill industry with a consumption of 3.7 hp. per wageearner. Whether preference is given to the employment of electrical power depends most likely on local conditions. There are certain industries that use a larger proportion of electrical motive power than others; but it is not always clear whether this is due to greater advantages of electrical power in that particular industry or to loca-

tion of the industry where electrical power can be easily obtained. Among the industries that have given preference to the electric motor for power should be mentioned the bakery industry with 80 per cent. of all employed primary power, the car and general construction shops of electrical railroads with 99 per cent., the car construction shops 91 per cent., the women's clothing industry with 87 per cent., the ammunition industry with 91 per cent., the foundry and machine shops with 79 per cent., and the jeweler's trade with 73 per cent.

Certain Large Industries Prefer To Use Central-Station Power

Not all the large consumers of electrical power are necessarily large customers for the central station. During 1914, in fact, 20 per cent. of all the electrical power used in the national industry was produced by the consumer. There are, however, industries that for certain reasons have always given preference to the employment of power rented from the central station. Among these the women's clothing industry takes the leading place by buying 97 per cent. of its power from the central station. The reason for this preference is that it is essentially a city industry carried on in big loft buildings where power is easily obtainable from the central stations and cannot be produced conveniently in the building. The men's clothing industry rents 82 per cent. of its electrical power requirements. The artificial-stone products industry is another city industry able to acquire externally produced electrical power easily and so buys it. The increase of electrical supply facilities makes itself felt also in many rural industries. The butter and cheese industry, which needs 5.7 primary horsepower per man, employs today one horsepower of electrical power per man and buys 73 per cent. of that from the central stations. The same is the case in the carriage industry, which employs 41 per cent. of electrical power, two-thirds of which is central-station power.

On the other hand, those industries that need most power for their production and that are making good use of electrical power are buying only a small part of their total requirements from the central station and are inclined to generate their own electrical energy by steam or other means. A study of the eighth column of the statistical table shows that the iron and steel smelting industry takes only 10 per cent. of its electrical power from the central stations and the rolling mills only 15 per cent. The cement industry takes 49 per cent.; but an exception is the ice industry, which buys 57 per cent.

Large Consumers Make Their Own Power

This policy of the larger consumers of electrical power is practically dictated by the desire to eliminate the middleman. After all, the central station is an undertaking supposed to make profits from the sale of power, and the big consumer may feel inclined to make this profit himself. This is especially the case with large iron furnaces and smelting plants, which, by using the resulting gases for the purpose of driving gas engines, have acquired a power source the advantages of which cannot be overestimated.

The expense bill for national industrial production is made up of three big items—cost of raw material, wages and cost of power. Of the total cost of production, 3.2 per cent. is chargeable to fuel and power. Under these circumstances it is of some interest to see how far the question of power consumption enters into the cost of production in each of the leading industries, or in other words, how much horsepower is required in each instance to produce a certain quantity of goods manufactured by that industry. The ice industry shows the largest application of power in comparison with the value of manufactures, as it has to employ 7.64 hp. to produce ice of a value of $1000. Next in importance is the paper and pulp industry, which needs 4.88 hp. of primary power for the production of each $1000 unit. Third stands the cement industry, with a power consumption of 4.81 hp. per each $1000 produced. Also the iron industry needs much power per $1000 unit of productive value. The blast furnaces lead with 3.84 hp. and are followed by the rolling mills with 2.94 hp.; 1.23 hp. is needed by the bolt and nut makers, while 1.31 hp. is required by the steel and iron forgers. Much power also is needed in the lumber industry, where 2.78 hp. is used per $1000 production.

How to Apply Statistical Table

It remains to see how the statistics of the table can best be made use of by the power consumer. The principal purpose for which they were prepared is that of checking power consumption in factories. For this purpose the fifth column will be put to use. By multiplying the value in that column by the number of wageearners employed in the factory desiring to make the test, a figure will be obtained showing what the power development of that factory should be on the basis of an average national power consumption. However, it should not be assumed immediately that power is actually wasted in the plant if the example shows a larger power consumption than that indicated by the national average, but an investigation into the power conditions in the plant should be made with a view to check overapplication of power, should this exist.

The same test can be made by central-station engineers with reference to their whole distribution field. The sixth column will prove useful to power engineers of central stations desiring to estimate the probable electrical power consumption in their own sales field or any new one to be developed. This column was made principally with the intention of showing what quantity of electrical power is used by the leading industries as a national average. It may be assumed that the electrical-power consumption in any given locality at least should not be below that usually found in districts similarly developed or having similar power facilities. It is recommended to use also the seventh and eighth columns in making these kinds of estimates and to compare the results of these investigations, which will add largely to the correctness of the final estimate.

Merchant vessels built in the United States during the fiscal year ended June 30, according to the Commerce Department, Bureau of Navigation, numbered 1622 of 1,430,793 gross tons. The output of the fourth quarter, 706,084 gross tons, almost equalled that of the preceding eight months, and is greater than any previous annual output in American history.

The Electrical Study Course—Faults in Generators and Motors—I

The general care of generators and motors and details of such ailments as they are subject to; the diagnosis, method of localizing, and manner of curing ills that are found to exist.

MOTORS and generators prove themselves to be very sturdy and will continue to operate satisfactorily under extremely severe conditions. Occasionally, however, faults do develop, sometimes owing to imperfections in construction, but much more frequently due to abuse of one kind or another. It is the purpose of the present lesson to briefly review the conditions necessary to maintain machines in good order and, more particularly, to give methods of testing for faults and for making temporary and permanent repairs when they are located.

Generators are usually under the constant supervision of attendants and are located to operate under favorable conditions except perhaps as regards temperature. They are therefore not prone to develop any ills. However, the following discussion is applicable to generators as well as motors, although some of the conditions described are not likely to apply to the former. Motors about a plant, and particularly the small and moderate-sized ones, are very likely to suffer from neglect unless some one individual is made responsible for their maintenance. Even then machines sometimes suffer from such causes as severe overloads which are not recognized for greater or less periods of time, so that even with competent supervision motor troubles will develop.

Lubrication of Bearings

Of course the most elementary thing to be observed is proper lubrication of bearings, and as this applies to all moving machinery it requires no particular emphasis in the case of the electric motor or generator. Another purely mechanical feature is the protection of the commutator when the motor is located in surroundings where there is any amount of grit present in the air. If left exposed, it will cut badly and wear down very rapidly even if no further trouble due to its roughness arises. When so located, the machine should either be entirely inclosed or screened thoroughly with fine-mesh wire cloth. When operating under proper conditions, the commutator should require practically no attention. A slight amount of commutator compound may be applied occasionally, but if a good grade of carbon brush is used it will generally be found to require practically no lubrication to preserve the highly polished deep-brown surface which is the indication of a well-kept commutator. For the slight amount of lubrication required, some operators prefer to use a very small quantity of oil or vaseline on a soft cloth held against the commutator while it is revolving. In dusty locations it is advisable to wipe off the commutator frequently and particularly after it has been at rest for any interval of time. In addition to care of bearings and commutator the machine should be kept clean and free from accumulations of oil-soaked carbon dust and dirt. Provided motors receive careful attention in these respects, any trouble that does develop is likely to be the result of misuse of one kind or another.

Overloading a Common Cause of Trouble

Overloading is responsible for much of the trouble encountered. If the brush contact area is liberally designed and commutation is good, a motor may be considerably overloaded without exhibiting any visual signs of distress. Overloading results in overheating and overheating results in deterioration of insulation, which is therefore a common cause of trouble. Just what constitutes a serious overload on a motor or like device practically depends on its ultimate temperature, which in turn depends on the temperature of its surroundings. The heating of a machine is due to its losses, which are composed of resistance loss, core loss and mechanical loss. For a given load on a machine there is a corresponding loss which is converted into an equivalent amount of heat, which in turn will raise the temperature of the machine through a certain number of degrees. That is, a given load will cause a certain rise in temperature of the machine, so that among the specifications of a machine the manufacturer guarantees that the *rise* in temperature at full load will not exceed a certain number of degrees.

Now what really determines the overload that a machine may be subjected to is, as stated, the final temperature that it attains, and not the rise in temperature that it undergoes. For example, we will assume that the temperature of a motor rises 20 deg. C. (36 deg. F.) at full load; if the temperature of the room in which it is located is 15 deg. C. (59 deg. F.), its final temperature will be 15 + 20 = 35 deg. C. (95 deg. F.). On the other hand, if it is being used on outside construction work the temperature of the surroundings might become very low—be at the freezing point for example. The surrounding temperature would then be 0 deg. C. (32 deg. F.) and for full load on the motor its temperature would become 0 + 20 = 20 deg. C. (68 deg. F.). Then again it might be in service in a particularly warm place such as in a poorly ventilated boiler or engine room in which the temperature reaches, we will say, 40 deg. C. (104 deg. F.); in that case the temperature of the motor at full load would be 40 + 20 = 60 deg. C. (140 deg. F.). In the extreme cases the ultimate temperatures are 20 deg. C. and 60 deg. C., although the load on the motor is the same in both cases. Consequently, if the insulation will stand up under the higher temperature, the motor could be very severely overloaded when in surroundings of low temperature. In fact, if brush contact and commutation permitted, it could be overloaded to the point that would give the same maximum temperature so far as injury to insulation is concerned. Of course it is not good practice to overload a machine even under these circumstances, since the purely mechanical design, such as that of the shaft and bearings, is not intended to

be subjected to great excess of load. Generally, sparking and heating at the brushes will indicate when the normal current has been considerably exceeded. Failure to reduce the load will in such a case at least result in roughness of the commutator with an increase of sparking, even if it should be attended by no other harm to the machine. It should be remembered also that a great overload on a machine will reduce its speed abnormally.

While it is true that a motor may be overloaded considerably without ill effect under certain circumstances, it should be borne in mind that the heating effect in a resistance is proportional to the square of the current flowing through it, which means that if we increase the current to 1.3 times normal, for example, the temperature rise will be 1.69 times what it was before; that is, while the current increase is only 0.3, the heating effect is increased 0.69, or 2.3 times as much as the current. In a shunt motor all the losses except those due to the current flowing through the resistance of the armature winding are practically constant, but that one loss varies as the square of the current, consequently the temperature of the machine will rise more quickly than the load upon it. In the case of the series motor the current through the field as well as that through the armature varies, and consequently the rise in temperature for a given increase in current will be even greater than in the case of a shunt machine. The increase in the compound-wound type will be greater than in the shunt but less than in the series, since there will be a loss due to the current through the series-field winding, which is absent in the shunt machine, but which is very much more pronounced in the series type of machine. Regardless of what may be the cause of the trouble, whether imperfect construction or abuse in operation, when it does develop it is accompanied by certain symptoms that make its presence known. The symptom observed generally indicates the kind of trouble, but it is often necessary to find its exact position in order that a cure may be effected. Among the more common ailments likely to be met with in ordinary operation are open-circuits, short-circuits, or grounds in either the armature or field coils. These will be taken up in turn, showing what symptoms are to be expected, how the exact position of the fault can be found, and what remedies, both temporary and permanent, are indicated.

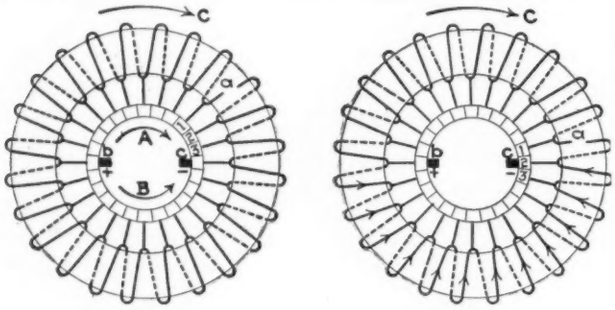


FIG. 1 FIG. 2

FIGS. 1 AND 2. EFFECT OF BREAK IN ARMATURE WINDING ON FLOW OF CURRENT THROUGH SAME

When an open-circuit occurs in an armature, its presence is made known by severe sparking at the brushes when the machine is running loaded. The spark is a brilliant one, giving the impression that a considerable current is being broken, which is actually the case. Let Fig. 1 represent the armature of a two-pole motor whose circuit is open at *a*. It is evident that no current can flow from *b* to *c* in the direction *A*, although it can in the direction *B*. Suppose the armature to be revolving in the direction of the arrow *C*. When it reaches the position shown in Fig. 2, the current in the coils between *b* and *c* will be flowing as shown by the arrows on the windings, there being no current in the upper half of the armature. As commutator bar 2 passes brush *c* and is replaced by bar 1 the current through the lower half of the armature is interrupted by the open-circuit and an arc is consequently drawn from the bar 2 to the brush *c*, being accentuated by the fact that the circuit broken is one containing considerable self-induction. This action recurs every time that the commutator segment 2 passes a brush, so that in a multipolar machine in which there is a pair of brushes for every pair of poles it would occur several times in each revolution. It would generally give the impression of a long drawn-out spark encircling the commutator, but if the armature were to be run slowly enough, the spark could be observed to occur at each passage of the segment from under a brush. In fact, that would be one way of locating the segment, although usually it can readily be discovered by the pitting at the edge of the bar caused by the arcing, which also destroys the mica between the segments 1 and 2. If it is desired to run the armature

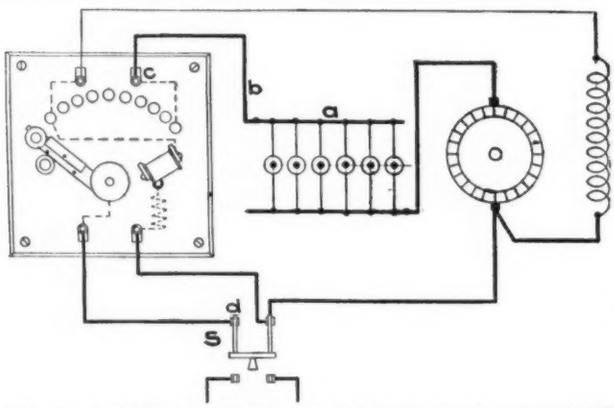


FIG. 3. LAMPS CONNECTED IN SERIES WITH ARMATURE TO REDUCE SPEED WHEN LOCATING OPEN-CIRCUIT

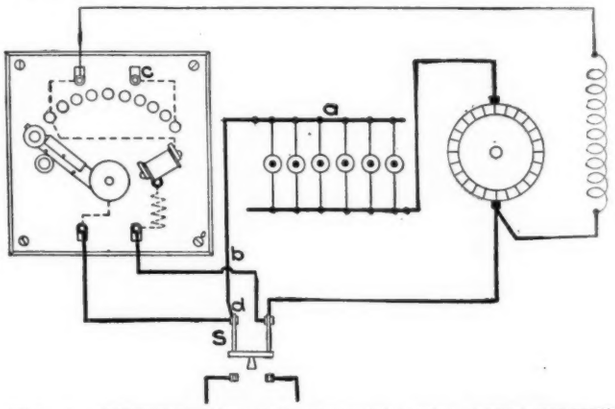


FIG. 4. CONNECTIONS FOR TESTING FOR OPEN-CIRCUIT WHILE ARMATURE IS STATIONARY

at a low speed, a convenient method is to connect a number of lamps in multiple, as at *a*, Fig. 3, and place them in series with the armature, as shown. If the motor operates on 125 volts or less, 110-volt lamps may be used, but if the voltage is higher, such as 220 or 500 volts, it will be necessary to connect two or more lamps in series for each one shown in the diagram, depending on the voltage used. If the motor does not begin to revolve when a considerable number of lamps have been turned on, it should be given a start by hand, upon which it will be found to continue to rotate of itself. The segment at which the flash occurs can then be readily detected.

If a low-reading voltmeter is available, a more satisfactory method is to remove from the starting box the armature lead which connects to it and place in series with this lead a number of lamps connecting the other side of the lamps to the supply switch. The connections

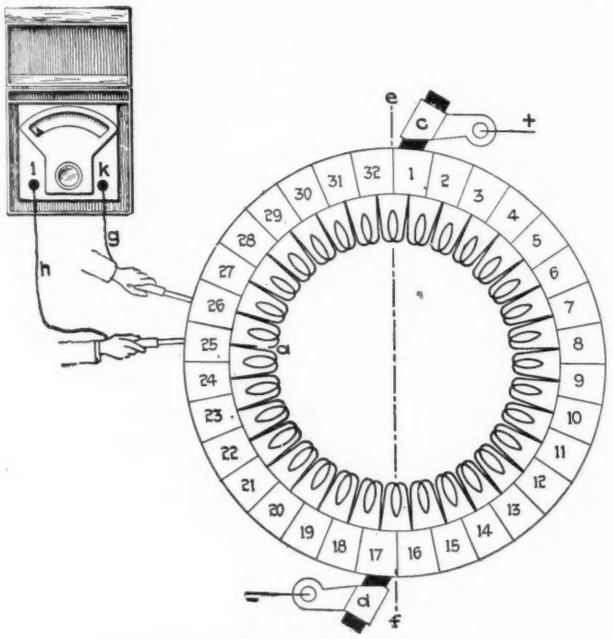


FIG. 5. METHOD OF LOCATING OPEN-CIRCUIT IN AN ARMATURE BY MEANS OF A VOLTMETER

would then be those shown in Fig. 4 and are like those of Fig. 3 except that lead *b* has been transferred from terminal *c* of the starting box to terminal *d* of switch *S*. When the switch is closed, current will flow through the armature but none can flow through the field, consequently the armature will not revolve. Let us now suppose that the motor is actually a two-pole one and that Fig. 5 is a representation of its commutator with the armature windings shown connected to it diagrammatically for the sake of simplicity; also that there is a break in the winding at *a*. Only a low voltage will exist between the brushes *cd* since there will be a large drop in voltage across the lamps which are connected in series with the armature. If the low-reading voltmeter is connected across *cd*, it will indicate the voltage that exists. If, now, the voltmeter leads be connected across segments 1 and 2, 2 and 3, 3 and 4, etc., the voltmeter will read the same voltage across each two, and this voltage will be the total voltage across *cd* divided by the number of coils in half the armature. This will be true for all segments to the right of the line *ef*. The circuit to the left of *ef* is broken at *a*, consequently no current flows through it and there will therefore be no drop in voltage across any of the coils in that part of the armature. The result is that when the voltmeter leads are applied to adjacent segments such as 17 and 18, 18 and 19, 19 and 20, etc., there will be no indication of voltage. When, however, contact is made across 25 and 26, as shown in the diagram, the voltage indicated will be that existing across *cd*, since the part of the winding from *c* to 26 merely acts as a continuation of the voltmeter lead *g* in connecting voltmeter terminal *k* to brush-holder *c*, and similarly the winding from 25 to *d* acts as part of the voltmeter lead to connect the terminal *l* to brush-holder *d*. The open-circuit may therefore be detected by determining across which two commutator segments a large deflection of the voltmeter is found as compared with the deflections obtained across any other adjacent segments. If the machine is a multipolar one, there will of course in general be as many brushes as there are poles, and in such cases a uniform drop in voltage will be found across all segments except those located between the two brushes between which is included that part of the winding in which the open-circuit occurs. It is evident that the open-circuit is within the coil whose ends connect to the commutator segments across which the increased voltage exists.

How to Correct the Fault

Having located the fault, the next point is its correction. To do this the armature must be removed from the machine, and the coil in question taken out and replaced by a new one unless a satisfactory repair can be made. If such is the case, care should be exercised that all injured insulation be removed and replaced with its fresh equivalent. In some instances it is highly desirable that a motor be kept in service for a limited time after it has developed an open-circuit, before laying it up for repairs. In that event a temporary repair can be effected by short-circuiting the injured coil by means of bridging the commutator segments to which it connects with a piece of heavy wire or a strip of flat metal. For the purpose of making such a connection holes may be drilled into the ends of the segments or into their risers, these holes being tapped and the short-circuiting connection attached by means of screws fitting into them. A continuous path is then offered to the current and the intense spark which was occasioned by the break in the circuit is thereby obviated. The motor may be run under these conditions for a limited time, but at the earliest possible occasion a permanent repair should be made.

The preceding discussion relates to a break in one of the conductors of the armature winding itself. It will, however, frequently be found that the open-circuit is occasioned by the fact that the connection between a coil and one of its commutator segments has been opened by reason of the solder, which makes the joint, having been melted out or having given way mechanically. The repair in such cases is very simple, involving merely the resoldering of the connection. In contradistinction to this simplest case, we have the one in which several breaks develop in the winding at the same time.

Testing with a voltmeter will under such circumstances lead to negative results if carried out as in the preceding instructions, and it then becomes necessary to elaborate on the method. The details of such a test, as well as a treatment of the other symptoms indicative of trouble, will be the subject of the next lesson.

The problem of the previous lesson involved a distribution system as illustrated in Fig. 6, in which the

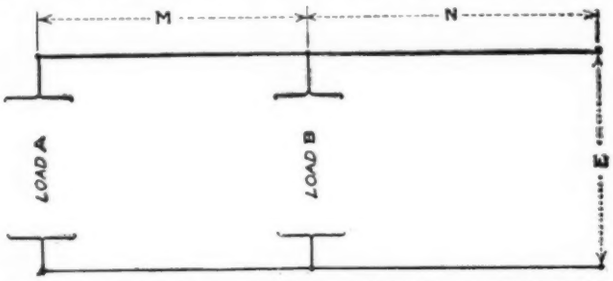


FIG. 6. DIAGRAM OF CIRCUIT SHOWING DISTRIBUTION OF LOADS AS SPECIFIED IN PREVIOUS PROBLEM

load at A consists of 109 fifty-watt 110-volt lamps and that at B of 76 sixty-watt 115-volt lamps. The voltage E is 125 volts and the lines M and N consist of 81 ft. of No. 8 wire and 205 ft. of No. 4 wire respectively. It is required to find the voltages at loads A and B and the total current furnished to them. The hot resistance of the lamps can be determined by finding what current they take at normal voltage and then dividing the voltage by that current. The current taken by each of the 50-watt 110-volt lamps would be the number of watts divided by the voltage, or $\frac{50}{110} = 0.4545$ ampere; the resistance would therefore be $\frac{110}{0.4545} = 242$ ohms. Since there are 109 of the lamps in multiple, the resistance of the entire load at A would be $\frac{242}{109} = 2.22$ ohms. The current taken by each of the 60-watt 115-volt lamps would be $\frac{60}{115} = 0.5217$ ampere, and the resistance therefore would be $\frac{115}{0.5217} = 220.4$ ohms. There being 76 of the lamps, the resistance of the entire load at B would be $\frac{220.4}{76} = 2.90$ ohms.

The resistance of No. 8 wire is 0.6158 ohm per 1000 ft. and that of No. 4 wire 0.2436 ohm per 1000 ft. The line M is 81 ft. long, so that the total length of wire in it will be $2 \times 81 = 162$ ft. and its resistance $162 \times \frac{0.6158}{1000} = 0.09976$ ohm. The line N is 205 ft. long, making the length of wire in it $2 \times 205 = 410$ ft. and its resistance $410 \times \frac{0.2436}{1000} = 0.09988$ ohm. To obtain the current taken by the entire load it is necessary to know the resistance of it. This resolves itself into a problem of series-parallel circuits. The resistance of load A plus that of line M is $2.22 + 0.09976 = 2.32$ ohms. This resistance is in parallel with that of the load B, which has been found to be 2.90 ohms. If R represent the multiple resistance, we have $\frac{1}{R} = \frac{1}{2.32} + \frac{1}{2.90}$, from which we find $R = \frac{2.32 \times 2.90}{2.32 + 2.90} = 1.289$ ohms. By adding to this resistance that of the line N we obtain the resistance of the entire system; hence we have $1.289 + 0.09988 = 1.389$ ohms.

Since the voltage E is 125 volts, the current taken by the system will be this voltage divided by the resistance connected across it, or $\frac{125}{.389} = 90$ amperes. The voltage across the load B will be that at E minus the drop in the line N, which is equal to the current through it multiplied by its resistance; consequently, voltage at $B = 125 - (90 \times 0.09988) = 116$ volts. The voltage across load A will be that across load B minus the voltage drop in line M, which is equal to the resistance of the line multiplied by the current through it. The current in turn is equal to the voltage across B divided by the resistance of the load A plus that of the line M, the sum of which has already been found to be 2.32 ohms. Therefore the current in line M is $\frac{116}{2.32} = 50$ amperes and its voltage drop $50 \times 0.09976 = 4.988$ volts, which makes the voltage across load A equal to $116 - 4.988 = 111$ volts.

The armature of a two-pole motor has a resistance of 0.075 ohm, and its commutator contains 24 segments. The field is disconnected so that the armature shall not revolve when current is passed through it. If the armature is then connected in series with a resistance of 2¾ ohms across 110 volts, what voltage will exist across adjacent commutator segments if there are no open-circuits in the armature? If there is an open-circuit, what voltage will be found to exist across it?

Elevator-Motor Controls

An elevator control to be used with squirrel-cage motors in sizes up to and including 20 hp. at car speeds not exceeding 150 ft. per min. has been built by the Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn., for both freight and passenger service. This equipment, Fig. 1, consists of a small control panel mounted on the wall near the motor, a car switch by means of which the operator controls the movement of the elevator car, and such elevator safety devices as may be desired.

A line contactor and two mechanically interlocked directional contactors are mounted on a black marine-finished slate base. The motor, being started with full-line voltage, requires no secondary or accelerating contactors. The contacts are graphite to graphite of the butt type and are interchangeable for the various contactors. The same contacts may be used for alternating-current and direct-current controllers for both car-switch and push-button operation. The car switch closes the line contactor and one of the directional contactors, and thus starts the car in the desired direction. When the operator, by means of the car switch, closes the circuit through the contactors, a shunt circuit energizes the brake magnet and releases the brake. If the car switch is returned to the "off" position or if any of the safety devices operate, the control circuit is opened, the brake magnet is deënergized, and the brakes are immediately applied.

The safety devices most commonly used are the emergency switch, to be used by the operator in case of accident to the car switch; machine-limit and hatch-

way-limit switches, which operate automatically to prevent accidents from over-travel should the operator for any reason fail to release the car switch; and door interlocks, which prevent the starting of the car until the door is properly closed.

The car-switch elevator control is used with alternating-current squirrel-cage motors of 20 hp., with a

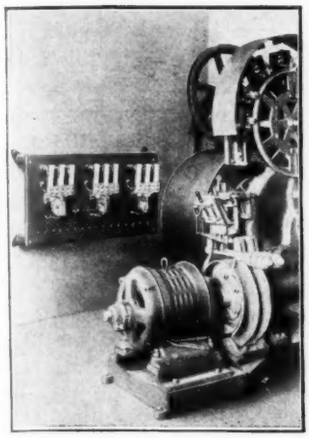


FIG. 1. CONTROL FOR SQUIRREL-CAGE MOTOR

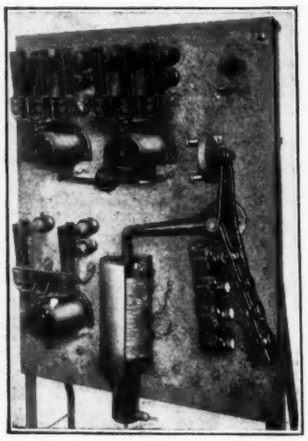


FIG. 2. CAR-SWITCH ELEVATOR ALTERNATING-CURRENT CONTROL

maximum of 220- 440- 550-volts. It is of the 25- and 60-cycle two- and three-phase type.

Single-speed passenger and freight elevator service requiring car speeds up to 150 ft. per min. can be successfully handled by another type of elevator control, which is used with compound-wound direct-current elevator motors. The control is quiet in operation and the car on which it is used is always under the direction of the operator.

The acceleration is smooth and uniform, being effected automatically, and as it is independent of the operator, it is impossible to injure the electrical apparatus by careless or ignorant manipulation of a car switch.

The control, Fig. 2, is designed with time limit acceleration with capacity for handling 10-hp. 115-volt or 20-hp. 230-550-volt direct-current motors.

A black marine-finished slate panel carries a main-line contactor, two directional contactors which are mechanically interlocked, and an accelerating contactor, controlled by a large air dashpot for cutting out the starting resistance and series field. The resistors are mounted on the rear of the panel, making the control apparatus a complete unit which can be mounted in any convenient place near the elevator motor.

Provision is made on the directional and line contactors for a shunt-brake circuit, which, when the control circuit is completed, energizes the brake magnet and releases the brake.

The contacts are graphite-to-graphite of the butt type and are easily renewed. A one-point car switch mounted in the elevator car furnishes the means by which the operator controls the movement of the car.

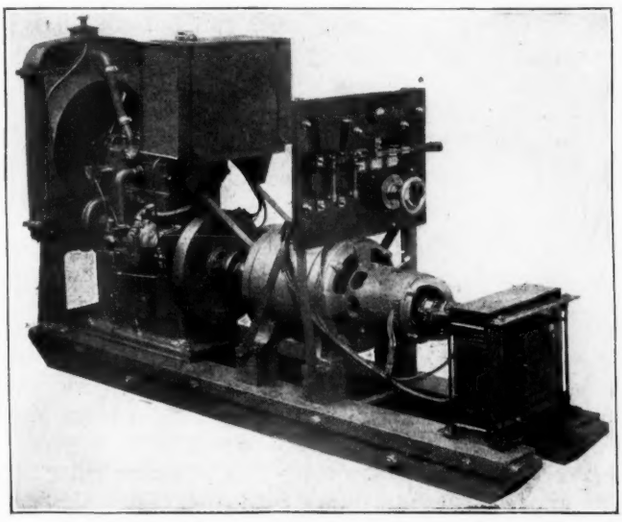
Safety devices may be connected in the control circuit so that the opening of any switch will bring the car to rest. Those most commonly employed are the emergency switches, to be used by the operator in case of accident or failure of the car switch; machine-limit and hatchway-limit switches, which operate automatically to prevent accidents from overtravel, should the operator for any reason fail to release the car switch; and door switches, which prevent the starting of the car until the door is properly closed.

Lincoln Portable Arc Welder

Although electric arc welding has been employed for several years in the iron and steel industry, its use has mostly been confined to factories, repair shops and other locations where the work can be brought to the machine. The accompanying illustration shows a new type of portable arc welder that presents interesting features and is designed for operation where electric current is not available.

It is manufactured by the Lincoln Electric Co., Cleveland, Ohio, and consists of a 150-ampere arc-welding generator direct-connected to a Winton gasoline engine and is intended for mounting on an automobile truck, or other convenient position so that it may be transferred from place to place.

The volts required to maintain a welding arc vary from 50 down to as low as 15 where a metal electrode is used. The welder uses a compound-wound generator the series winding of which is connected up so as to oppose the shunt field, and the two windings are so proportioned that the voltage decreases in the same ratio as the current increases, thus limiting the short-circuit current. Another effect of this is that the horsepower and therefore the heat developed for a given set-



PORTABLE GAS-ENGINE-DRIVEN ARC WELDER

ting of the regulator switch (shown on the control board above the generator) remains practically constant.

Additional arc stability is also insured by the stabilizer (seen at the extreme right of the picture). This is a highly inductive low-resistance coil connected in the welding circuit. It serves to correct momentary fluctuation of current in much the same maner as the flywheel of an engine produces an even turning speed.

An interesting feature of this welder is that it has been designed to insure a steady arc and a constant and readily controllable heat.

Preventing Waste of Fuel Oil

By RUFUS T. STROHM

Because the majority of steam-power plants use coal as fuel, the United States Fuel Administration has laid especial emphasis on coal saving. The necessity for reducing waste of fuel oil, however, is equally important, in view of the rapidly increasing demand for oil for marine service.

SINCE the outbreak of the war the United States Navy has been greatly enlarged. Unofficial reports have stated that the present number of vessels of all classes is approximately 2000, which is about ten times the number in existence when the war began. In addition to this increase in the navy, the country has been turning out merchant vessels at an unprecedented rate during the last year.

For marine service oil forms an ideal fuel, whether it is used in boiler furnaces for the generation of steam or in internal-combustion engines for the production of power direct. It has also been used to a considerable extent in the firing of stationary boilers, notably on the Pacific Coast and in the New England States. But now that the shipbuilding program and the needs of the allied forces have put so great a pressure on the oil-producing industry, care in the use of oil fuel has become imperative.

Such causes of oil waste as leaks in pipe lines, tank seams, valves, fittings and other parts of the oil system usually are easy to detect and the remedy is obvious. If the oil is received in tank cars and is unloaded by gravity, care should be taken not to allow oil to run to waste when the discharge pipe or hose is disconnected.

The efficient burning of oil fuel depends on thorough atomization and mixing with sufficient air. Atomization is accomplished by the burner, and for that reason an efficient form should be used. Home-made burners, built up of pipes and fittings that are easily and cheaply obtained, are often used; but while they answer the purpose, they do so in a wasteful manner. The oil should be broken up into small particles, so that vaporization may be more quickly effected and a more intimate mixture with the air may be obtained.

Perhaps the greatest waste of oil in steam-boiler firing arises through improper regulation of the air supply. If the amount of air admitted is much less than that demanded by the quantity of fuel being fed, the fire will not be smothered. The burner will continue to operate, but the excess of oil that cannot get enough air to cause it to burn will simply be converted into vapor and will escape up the chimney. Thus the fuel will continue to disappear into the furnace, but will fail to produce the heat that it should produce.

Too great a supply of air will waste fuel. It will increase the quantity of furnace gases and lower their temperature, so that the rate of transmission of heat to the water will be slower and a greater amount of heat will escape with the gases through the chimney. With oil the mixture of air and fuel is so much better than with coal that a much smaller excess of air needs to be admitted to an oil-burning furnace to insure complete combustion. Instead of from 50 to 100 per cent. excess as in the case of coal, oil may be burned with as little as 10 per cent. of excess air, and 25 per cent. is a common figure. The fireman who changes from coal burning to oil burning is therefore particularly liable to waste oil by admitting too much air.

The most satisfactory way to regulate the air supply to obtain the most economical results is to analyze the flue gases and to cut down the air admitted until there is a maximum of carbon dioxide with a minimum of carbon monoxide. If the plant has no analyzer the air may be regulated fairly well by observation of the gases leaving the top of the chimney. With the ashpit doors wide open, the damper should be closed slowly until smoke begins to issue from the chimney. Then the damper should be swung open very slowly until the smoke decreases to a barely distinguishable light haze, and the damper should be left in that position. The appearance of smoke as the damper was closed indicated too little air and incomplete combustion and the disappearance of smoke as the damper was opened indicated that a point was reached at which the air supply was sufficient for the quantity of fuel being used.

Faulty atomization is responsible for waste of oil. This may come about through a variety of causes, such as clogging of the burner passages, variation in the pressure of the oil and insufficient heating of the oil.

Clogging of the burner may be caused by particles of dirt or grit in the oil. Therefore, the oil should be strained on its way to the burner, in order to catch all solid matter. The strainers should be in duplicate so that it will be unnecessary to interrupt the flow of oil when cleaning must be undertaken.

The oil goes to the burner under pressure, which may be produced by a standpipe or a pump. In any case, the pressure should be uniform, because a fluctuation of pressure will produce a change in the rate of oil feeding and will destroy the balance between air and fuel adjustments, thereby causing waste of oil.

For the same reason the temperature of the oil should be kept uniform. A change in the temperature of the oil will alter its viscosity and consequently the rate of flow under a given pressure and so will disturb the ratio of oil to air. With steam atomizing the temperature may be considerably lower than with mechanical atomizing. Very viscous oils must be heated to a greater extent than the more fluid ones.

The usual precautions against leakage of air through the boiler setting into the gas passages should be observed. It is advisable to have an oil meter in the plant and to keep a daily record of the amount of oil used. Comparison of such records from day to day will serve to indicate whether the plant is growing more economical or more wasteful.

Shutdowns cause fuel waste because of the cooling down of the boilers and settings and the necessity of heating them up again on starting. To guard against such interruptions, ample oil storage should be provided. Storage-tank openings should be kept closed to reduce the loss of oil by evaporation to a minimum.

Economizers from the Viewpoint of a Designing and Operating Engineer

By LOUIS R. LEE

In which the writer takes issue with the "Chief" in the "Visits of Inspector Brown" series of articles and upholds the reliability and value of economizers in the power plant.

THE modern plant is essentially made up of three classes of equipment: First, equipment for the combustion of fuel; second, equipment for converting the heat obtained by the combustion of fuel into steam; third, equipment for converting the energy in steam into mechanical or electrical energy. In other words, we have the usual coal-burning furnaces comprising the modern stoker in its different forms; second, the steam boiler with its accessories of feed-water heater and economizer; third, steam turbines or steam engines and their accessories.

It seems under our present knowledge of thermodynamics hard to conceive the idea that we should do away with any of these known agents for extracting the maximum heat from the combustion of fuel. It is well known that we actually convert a very small part of the heat that is given up by the coal into useful energy. Our whole strife should be to add agents to this known group, which may increase the thermal efficiency of our power stations.

The Reliability of Economizers

The chief, in the Inspector Brown series of articles, seems to try to set up in the mind of his subordinate, the inspector, a doubt as to the reliability of economizers. This seems to me to be wrong. For example, why should he not raise the same doubt regarding steam boilers? There are a great many more steam-boiler explosions than there are of economizers. First, because there are more steam boilers and, second, because they as a class receive harder service and thereby depreciate faster. They are closer to the fire and some of the parts are more likely to become burned. For example, tubes are frequently lost in the best modern water-tube boilers and even in the most modern stations. One of the reasons for this is that the tubes are not clean. That does not condemn the boiler equipment, however; it only emphasizes the need of giving the equipment proper attention. The modern water-tube boiler is so constructed that the loss of a tube usually means but little damage in the station, although some very serious accidents have resulted.

Economizers have a specific function in a power plant. To the best of my knowledge there is no substitute yet perfected. Out of a score of installations with which I have had more or less to do in the way of designing, construction and operation, I have yet to know of a single failure, and more than that, I have yet to find a case of near failure. I have known several cases where economizers were in service for many years, one for example, for eight years, in which the repair required was nil, where if certain instruments had not been provided for showing the heat transferred it is possible the men in the station would not have been conscious that such equipment was in use. I dare say that in the stations in which I have had experience the economizer has been one of the most satisfactory pieces of equipment. This probably is due to the nature of the equipment and the quality of material used in its construction. Economizers have been made in two ways: First, and most successfully, using cast-iron tubes; second, and not so successfully, using teel tubes. In nearly every case the steel-tube economizer has sooner or later failed because of corrosion. The cast-iron economizer has not failed from this cause, and the best records show that the tubes in the economizer will last almost indefinitely so far as corrosion is concerned.

High Pressures of Economizers

The Chief states that economizers usually operate at very high pressures. I suppose he means by this that the economizer is usually operated at the boiler pressure, plus such pressure as is needed to force the water through the economizer into the boiler. For example, in the case of a boiler carrying 100 lb. pressure the economizer will carry, say, 120 lb. This would not be a very high pressure; in fact, it would be moderate. Recently, however, a number of installations have been made where the boilers carried from 250 lb. upward, with the economizers carrying sufficient additional pressure to allow the water to be forced through them into the boilers. I have had to do with two installations where the boilers carry 250 lb., and I know that there has been no trouble experienced in these layouts. I know of several other installations of higher pressures, but undoubtedly there is a reasonable question as to the upper limits of pressure that should be used on economizers, or on boilers and piping for that matter.

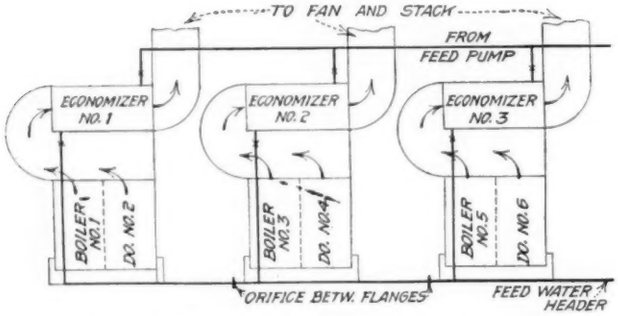
High Pressures May Be Made Safe

As I see it, high pressure in itself is not a hazardous thing—it simply means more expenditure for the equipment. Piping can be arranged for carrying steam under almost any known pressure, but it becomes much more expensive to make joints tight and to secure valves that will be tight under very high pressures. It is up to the designing engineer to balance the first cost and the cost of maintenance against the savings obtained. The maintenance can be obtained only by experience, but figures can be made on pressures already in use and estimates can be made on higher pressures. It has been my experience that 250 lb. is well justified over 200 lb. pressure. It allows steam lines to be made smaller than they would be if 200 lb. were used, and I certainly would not advise using 200 lb. for even a medium-sized steam-turbine station. The higher pressures limit the use of small steam auxiliaries, but possibly we have hung on to small steam auxiliaries too long and getting away from them will be a forward step.

There is now quite common in power plants one piece of equipment which makes the use of high pressures on economizers more feasible, and that is the centrifugal feed pump. This furnishes a steady flow of water, whereas the reciprocating pump gives a pulsating flow.

The Chief is quite right that care should be taken to see that a flow of water is maintained through the economizer. It is true that the relief valve on the economizer is not as successful as the relief valve on a boiler, but its measure of deficiency is not that it does not work but that it works too often. It adds nothing to the hazard of a plant that the relief valve on an economizer will leak; it decreases the efficiency of a plant, but I cannot see how it can increase the hazard of operation. By using a very high grade of valve and by giving the valve close attention the leaking can be reduced to a very small amount. However, to take care of this small amount suitable piping should be arranged so that the hot water will return to the hotwell or feed-water storage tank in order that the water itself will not be wasted, nor all of the heat that it contains.

It certainly should be left to the choice of the operating company whether or not bypasses for the gases around the economizers are provided. It may be found by one company that it is cheaper and better to install an economizer with one or two boilers as a unit, without



ORIFICE METHOD FOR FEED-WATER HEADER

bypass for the gases around the economizer. Certainly, there should be no question of insurance raised upon this point, as such an installation can be safely operated.

The Chief seems to have great fear that the tubes will pull out of the header. I have never heard of a case of this kind and doubt very much if there is any evidence to prove any such contention. The analogy between removing a car wheel by heating the wheel is very far-fetched and, in my opinion, not at all applicable to the economizer header.

I wonder if the Chief would expect boiler tubes to come loose in the same fashion? I have heard of boiler tubes coming out of the header, but have never heard the Chief's theory advanced before. The danger due to steam in the economizer is in water-hammer. There is very little danger of installing so much economizer surface that steam will be formed in the economizer. It will form, if there is no flow of water through the economizer. Such a condition may arise from stoppage of the feed pumps, closing of regulator valves, or by careless closing of the outlet valves on economizers. I have yet to find an economizer installation that had too much surface, and I doubt if there are any such cases. Usually, the surface could have been larger from an economic as well as from an operating standpoint.

The Chief lays great stress upon series vs. parallel operation. Now, there is a third way that economizers have been successfully used, which has the merit of being nearer foolproof than any of the schemes suggested by the Chief, but which probably has never even been tried. The illustration shows the use of an orifice and illustrates the method. Many will recognize this as an application of a similar method used in hot-water heating systems.

The Chief says that the outgoing gases should always be 180 deg. F. hotter than the incoming water, but he does not give any reason for selecting 180 deg. rather than any other arbitrary figure. Too much surface is secured only when there ceases to be a gain in efficiency. The price of fuel, draft conditions and kind of boilers are the principal factors that will influence the efficiency question.

As far as that goes, just why is it up to the insurance inspector at all to figure out the efficiency of the plant or any part of it? Does he determine in insuring an engine for flywheel explosion the efficiency of the engine and then decide whether insurance is allowable? Or, likewise, in insuring the steam turbine? Must the inspector have a head full of data and formulas to determine efficiency of plants? Insurance for efficiency would certainly be a novel kind to have, but possibly it would be very popular.

Needless Lights Waste Coal

"There is great saving of coal possible by proper care in interior lighting of homes," said Mercer P. Moseley, Chief of Conservation. In discussing the subject he said:

"Do you realize that the use of each electric light (or gas jet) means the consumption of coal?"

"Why? Well, because

"Coal is burned under boilers to make steam.

"Steam propels the engine that turns the dynamo.

"The dynamo produces the electric current which lights the lamp you turn on.

"It requires five pounds of coal to furnish the electric current necessary to light one 25-watt lamp for 100 hours.

"Therefore, every time you turn on an electric light, you are using coal.

"Every light you do not turn on means a saving of coal and a saving in money for you.

"Now, please

"Do not burn more lights than are necessary for your purpose.

"Do not leave any light burning when you are not using it.

"What about the hall cluster of lights—wouldn't one or two do?

"Don't 'light up' the whole house to keep from being 'lonesome.'

"Unnecessary illumination is not patriotic pastime nowadays.

"Your help is needed.

"Will you, or won't you help?"

The monster turreted iron-clads are the direct descendants of Ericsson's "Monitor" and the Confederate ram "Merrimac."

EDITORIALS

Record Breaking Versus Eternal Vigilance

EVERY now and then the newspapers regale us with a highly colored account of a ship-worker who has broken all previous records in the matter of the number of rivets driven per day or a miner who has produced an almost unbelievably large amount of coal in a certain working period.

These things make good reading and we feel highly pleased that we have workmen who are able to accomplish such surprising results. But without detracting at all from the glory of their achievements, it is well to call attention to the fact that these cases are exceptional.

If it were not so, our shipbuilding program would be months ahead of its schedule and there would be enough coal on hand to carry us through the winter without the least danger of frosted toes and idle plants.

The bulk of the output in any industry is due to the average worker. The spectacular performer makes a star effort and his name gets into the headlines for a day; but we never learn what his average is. If we did, we might be astonished.

Speed kings tear up dust at the rate of a mile in half a minute, but the majority of motorists run along at a reasonable rate even when the police are not watching.

A record performance in any line is like perfection—something to look up to and strive for, without too strong a hope of reaching it.

There are some boilers that have shown efficiencies of eighty per cent. and more. Such a high degree of efficiency did not just happen. It was the result of close attention to every detail of operation. The heating surfaces were clean, the combustion was right, there was a minimum of excess air and the effort of the entire force was concentrated on getting full value out of every last heat unit during the period of the test.

Therein lies the secret of high efficiency—keeping vigilant watch and forestalling every possible loss. The best boiler and furnace ever designed would soon drop to the level of the average if they were not properly maintained.

It is possible to get an average efficiency of over seventy per cent. by paying closer attention to the operation of the ordinary run of boilers. But fuel is not saved by running them under test conditions for one day in a month and letting them take care of themselves the remainder of the time.

It's a case of hare and tortoise all over again. The hare made a splendid get-away and monopolized the applause, but the tortoise quietly plugged along and brought home the purse.

Someone may temporarily startle the engineering fraternity by adding another one-tenth to the highest previous boiler efficiency; but the men who are going to save that fifty million tons of coal for Uncle Sam are the quiet, patient fellows who are keeping everlastingly on the job of plugging up leaks.

Reconstruction After the War

TECHNOLOGY, which embraces all the arts by which people make a living, more and more crystallizes into government. The trend is as it should be, of course, for it is materials and the skill and knowledge of men to shape them to the nations' needs that is the material purpose of life and to serve which government and law exist. So the more technology crystallizes into government the less impeded is the business of making a living and the greater becomes the nation's productive and distributive power.

Now when our whole national makeup has been converted to the direction and execution of war, it is vital that action be taken to better prepare the nation for the adjustments and reconstruction to follow peace than we were prepared for the exigencies of war. It is a task of colossal proportions, and while there will be more time for adjustment to take place than there was when we prepared to hold back a menacing foe, it must be remembered that there will be great advantages to that nation which soonest can begin with least lost motion the business of a world at peace.

Congress has passed a concurrent resolution anthorizing the appointment of a joint congressional committee on reconstruction. Twelve huge problems are given this committee, namely: Those affecting labor, those affecting capital and credit, those resulting in the demobilization of industrial and military war resources, those affecting public utilities, those affecting foreign trade, those relating to the continuance of existing industries and the establishment of new industries; others relate to agriculture, production and distribution of fuels; shipyards and shipping, disposition of Government war structures, repeal, extension or amendment of war legislation, and . . . "all matters necessarily arising during the change from war activities to the pursuits of peace."

The importance of getting a right start in this work cannot be too strongly emphasized. When the war emergency came, the old methods, most of the customary channels, failed to respond with sufficient force and alacrity to meet the needs of the hour. Technology had to come to the rescue of industry, government and credit capital. American technology has demonstrated that it was capable of performing the impossible. It is, perhaps, no exaggeration to say that American technology was the determining factor in winning the war and the technology of our Allies held off the Teuton until American technology could mobilize and strike. American technology is mobilized in complete fashion through the various technical societies; it is functioning now for national good, with the efficiency of all the United States as its prime purpose. In all the problems confronting the Committee on Reconstruction technology is vitally concerned and can be of just as much invaluable service as it was and is in the business of conducting the war. The committee needs the engineer

in this work, and the engineer must feel it a national duty to see to it that he is made use of. The Federal Reserve Board and the War Industries Board should work in the closest relationship with the engineers of the country.

Still a Barbarian

AS THE pleas for peace come thick and fast from Germany and the fullest measure of protection for her people and her property are demanded, press reports tell of the ruin of the coal fields of Lens. The only coal of fair quality that France possesses is that in and about Lens. Since the German occupation the enemy has operated these mines continuously, removing considerable coal. Now that the Hun has been forced to retreat, he has flooded and wrecked the mines so badly that experts report that they cannot be worked at all for nearly two years and that fully five years must elapse before normal output can be had from these pits.

Well, it is to be expected; it was expected, in fact, and for two years English, French and American effort has been directed toward the immediate rehabilitation of these mines as soon as the German was driven out. It is estimated that fifty thousand horsepower of pumps and similar machinery are ready to begin the work of pumping out the mines.

The normal output of the Lens coal fields was, according to cable reports, twelve million tons a year. Long ago coal cost a hundred dollars a ton at the seaports of France. Think what half the output would do to relieve the acute suffering in France this coming winter. Yes, think about it, and then vow you will cut your own coal consumption that you may do your part to make coal available for our boys in hospitals there.

Free Energy Found

A SOURCE of free energy has been discovered—not by Garabed Giragossian, not by any obscure pursuer of the *ignis fatuus* of the *perpetuum mobile*, but by the United States Railroad Administration.

Charles H. Garlick, who has had a lifetime of experience as a practical engineer in the mills of Pennsylvania, whose eminence in the field of operative steam engineering has been recognized by his election as its president by the National Association of Stationary Engineers, relates on page 642 an experience that will make every friend of the Railway Administration and every proponent of the continued operation of the railroads by the people apprehensive and ashamed. Returning from the convention of the N. A. S. E. at Cincinnati, Mr. Garlick was struck by the incongruity of the food and fuel conservation signs with which the parlor car was placarded and the twenty electric lights which burned brightly throughout the sunny day. He called the attention of the Office of Suggestions and Complaints at Washington to the matter and received the astounding reply:

> "Your letter would indicate you are under the impression that generally the current for electric-lighted cars is generated through an agency requiring the use of coal. The current for most of the electric-lighted cars is generated by a dynamo connected with the car axle, and *no agency requiring coal is used.*

Mr. Garlick rejoined that if it does not take any fuel to operate the light from the axle, it would be an excellent idea to use larger generators and operate the train without any engine, whereupon the tolerant typewriter in the Washington Bureau of Suggestions and Complaints patronizingly informs him that the generator on the axle is running all the time whether the lights are on or not, so what's the use of turning them out?

We know that engineers are too scarce and valuable to use in a Bureau of Complaints and Suggestions, but where did the Administration find even a typewriter who did not know that the turning on of lights added to the work of even a running generator?

Better Oil-Testing Methods

THE suggestion by Professor Trinks, on another page, that the readers of *Power* participate in a general discussion of the whole subject of cylinder and valve lubrication is heartily indorsed. Correspondence is invited on all practical phases of the subject, such as the amount of lubricant used per million square feet of surface swept over, the means employed to duplicate or determine whether a new lot of oil is like one found to be good, what qualities are called for in ordering or are found lacking in unsatisfactory oils, etc.

All statements should include the operating conditions as to piston speed, condition, both normal and extreme, of the steam, type of engine and the like, so that a reasonably fair comparison can be made. All of the foregoing, however, presupposes a certain amount of experimentation which Professor Trinks hopes may become unnecessary when a method is found of determining beforehand that the essential qualities are present in the oil. A full discussion "without mental reservation" should be of great benefit to all.

Chairman Hurley of the Shipping Board does not exaggerate when he asserts that the firemen of our merchant ships are in our first line of defense. The American forces in Europe are dependent on supplies from home, and to maintain these supplies there must be an unbroken bridge of ships. The epidemic of influenza has seriously reduced the number of available firemen; therefore, men who are qualified for this sort of patriotic service should quickly respond to the urgent call for two thousand volunteers on page 652.

The coal docks in New Jersey which supply New York and Connecticut are said by the New York State Fuel Administration to be in condition to care for the City's coal demands. Cheering news. However, we are soon going to look around down there.

It is a pleasure to be advised by the Fuel Administration that coal may be stored; but just where is the coal?

This is a good time to prepare for overhauling the refrigeration plant.

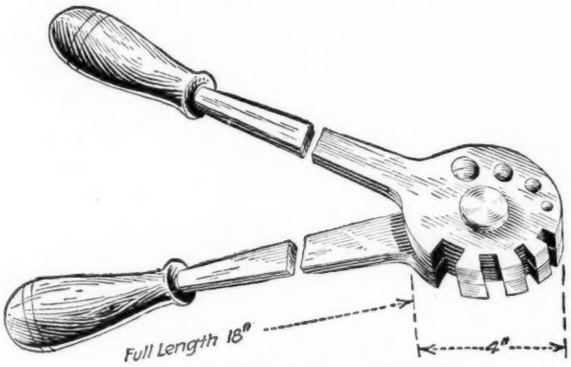
Where is "Der Tag" we used to hear so much about?

CORRESPONDENCE

In these and other columns "Power" wants to tell how you have decreased the fuel consumption in your plant. Since the fuel shortage, engineers have been thinking hard about conserving fuel. Thousands have made changes in equipment, in operating methods, and in modifications to boiler settings, etc., all of which have, in many plants, greatly cut fuel consumption. You owe it to the country to tell your fellow-engineers how you have saved coal. "Power" will pay for good articles that will help the other fellow save coal as you have saved it. Engineers must save at least 35 million tons this year. Let's have your story.

A Powerful Wire Cutter

A handy tool can be made as shown in the illustration if one is willing to utilize some of his spare time. It is a wire cutter made of $\frac{3}{16}$-in. tool steel that is



AN EASILY-MADE WIRE CUTTER

first annealed to make it easy to work; then after the tool is finished it is again hardened. The cutter will "bite off" heavy copper or tough steel wire that cannot be cut with either pliers or shears.

Ozone Park, L. I. M. P. BERTRANDE.

How Was the Coal Saved?

Mr. Bement's article in the Oct. 8 issue prompts me to ask how the coal was saved?

Henry Kreisinger, in Technical Paper 137, shows that no matter how much air is supplied under the grate, if the fuel bed is maintained in proper condition the maximum amount will equal about 50 per cent. of the required quantity for proper combustion, and additional air must always be introduced above the fuel bed for perfect combustion.

In test No. 31 the air pressure in inches of water in the ashpit was maintained at 2.83, the combustion rate was 99.5 lb. and the weight of air was 645 lb., or 6.5 lb. of air supplied per pound of fuel fired; so if the fuel bed was maintained properly in all cases with the same load, how was the coal saved?

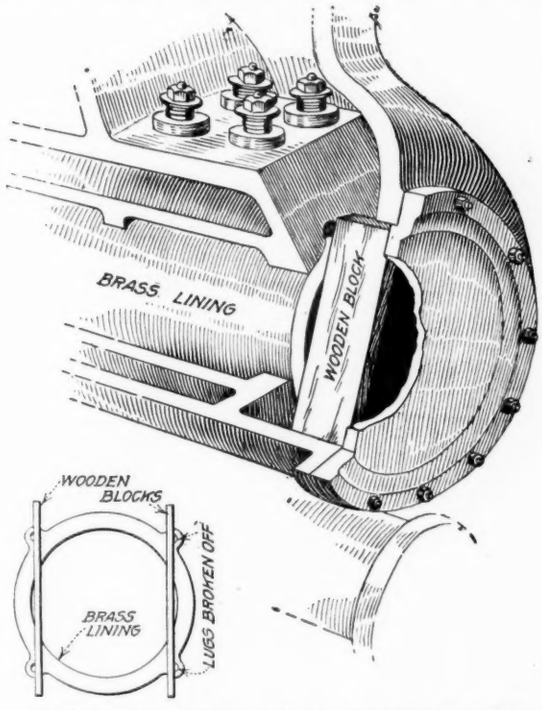
Regulation of draft by the ashpit doors is condemned by the combustion engineers for these reasons: It shuts off the air supply through the fuel bed so that the ash on the grate and the grate itself become heated. If the temperature rises to that of ash fusion, it produces clinker. The repeated heating of the grate bars causes warping and shortens their life. A higher pressure drop is also created in the furnace, causing much increased air infiltration, creating excess air to absorb heat that should go into the water.

While seven or eight pounds of air per pound of coal is required over the fuel bed, we want that air supplied under control always. This, of course, is not attainable through air leakage. Draft should always be controlled by the damper in the uptake, in hand-fired furnaces. A. J. DE FREEST.

New York City.

Emergency Pump Repairs

In the plant of which I have charge there is a $7\frac{1}{2}$ x $4\frac{1}{2}$ x 10-in. duplex pump for pumping cold water into the tank that supplies the heaters. This water seems to have a corrosive effect on the cast iron of the pump,



LINING HELD IN PLACE BY WOODEN BLOCKS

especially around the capscrews that hold the brass lining in the water end, for it ate away the threads so that the screws would not hold the lining in place. After taking the water-end head off, we found the lining loose, all the screws out and the four lugs broken off. The pump was badly needed and some way had to be found out of the difficulty; the illustration shows how it was done. By placing pieces of wood about 6 in.

long, $\frac{7}{8}$ in. thick and about $\frac{1}{32}$ in. wider than the distance between the end of the lining (when it was in place) and the head and pulling the head up solid, we were able to use the pump and keep up the supply of water until a new lining was procured.

Philadelphia, Penn. O. V. BAKER.

Free Energy Found!

During the week of Sept. 9 to 14 the writer attended a convention of the National Association of Stationary Engineers at Cincinnati, Ohio. While there he had the pleasure of hearing Mr. Noyes and Mr. Myers, of the Fuel Administration, speak on the subject of fuel conservation. The addresses were splendid and will do much to inspire the members of the organization to greater efforts to save fuel.

On the morning of Sept. 14 I left Cincinnati for Pittsburgh on a train leaving at 9 o'clock, and during the journey twenty electric lights were burning in the parlor car where I occupied a seat. As the United States Fuel Administration had the car placarded with invitations to make suggestions or complaints that would tend to greater economy in the use of fuel, I wrote to the Director General of Railroads, Office of Suggestions and Complaints, at Washington, that I thought it unnecessary to have the lights burning on a bright, clear day, except at such times as the car was passing through a tunnel, when an attendant could turn the light on and off as required.

On Oct. 2, I received from the United States Railroad Administration a letter of which the following is an abstract: "On behalf of the Director General I wish to acknowledge receipt of your letter of Sept. 19, suggesting that instructions be issued to prohibit the burning of electric lights in parlor and other electric-lighted cars as a coal-conservation measure. Your letter would indicate you are under the impression that generally the current for electric-lighted cars is generated through an agency requiring the use of coal. The current for most of the electric-lighted cars is generated by a dynamo connected with the car axle and no agency requiring coal is used." This letter would indicate that the writer is not familiar with the natural laws that govern the development of power, and this suggestion was made to him in a letter dated Oct. 2: "If it does not require any fuel to operate the lights, it would be a splendid idea to connect the axle with larger dynamos and operate the train without using a steam engine." I also took advantage of the opportunity to suggest that it would be a good idea for the Director General of the Railroads to engage a few real engineers.

In answer to my second letter I received the following, unsigned:

> Referring to your letter of October 2d, in connection with the method by which current for electric lighted cars is provided, You are perhaps familiar with the fact that the dynamo which generates the current, and which is operated by the car axle, is kept in motion whether the lights are burning or not. This is on account of the fact that no practical method has as yet been devised which will permit of stopping the generator when the lights are not in use, and at the same time providing for its operation so as to insure sufficient storage to permit of electric lights being available for the comfort and convenience of passengers, as required when cars are standing. If you have any ideas along this line, the railroad administration would appreciate being given an opportunity to consider them.

Following is the gist of my reply:

> The writer has no desire to enter into a letter-writing contest. He made a perfectly good suggestion which you proceeded to ignore and belittle, and incidentally demonstrated that you do not know anything about the subject. When the dynamo connected with the axle is operating without generating power the steam from the boiler simply has to overcome the friction of the dynamo, but when supplying the lights or when charging a storage battery the energy from the boiler not only has to overcome the friction of the dynamo, but is used in developing the power. There is no gainsaying the fact that lights burning represent coal used to generate the current for these lights. Every light unnecessarily burned means a waste of fuel.
>
> CHARLES H. GARLICK,
> State Steam Boiler Inspector for Allegheny County.
> Pittsburgh, Penn.

Correct Location for Cylinder-Lubricator Pump

I have three cylinder lubricators, of the pump or force-feed type, that in times past gave me no little trouble, getting hot and failing to work until cooled down again. I overcame the difficulty by lowering the pump one-half inch below the discharge into the cylinder so that there is oil in the lower part of the pipe at all times and the steam can't get back into the pump.

I hope this little item will help some reader of *Power*. I would have been willing at one time to part with "good money" to know how to overcome my difficulty.

Gatliff, Ky. DAVID R. MONTGOMERY.

Supporting Effect of Boiler Heads

The lively discussion as to whether the supporting effect of a boiler head should be taken into account in finding the size of a stay interested me greatly. I agree with Mr. MacDonald in his conclusions, but I believe that he was unfortunate in choosing the rope-and-wall illustration to explain his views.

If a flat plate is held at the edges and subjected to a uniform pressure over its entire area, it will tend to take the shape of a spherical surface. If the deflection is measured as the load is regularly increased, it will be found that the bulging of the plate is greatest during the early stages of the application of pressure and that when the limit of strength of the plate is almost reached the increase in the deflection for a small increase of load is very much less than for the same increase of load in the early stages. In other words, the resistance of the plate increases as the bulging grows greater.

Now, let these facts be applied to the case of a flat head under pressure. By the very construction of the boiler the stays may be assumed to be taut; that is, there is no play or slack in the connection between the stay and the head. Therefore, as soon as the pressure comes on the head, it tends to bulge outward; but as there is no backlash to be taken up, any movement of the head at once throws the pressure on the stay and the stay carries the load. Of course, the stretching of the stay lets the head carry part of the load, but the part is negligible.

If the construction were such that the head could bulge outward until the full effect of its resistance was obtained before the stay began to take any of the load, then it would be permissible to make allowance for the part of the load sustained by the head. But with boilers

as they are built it is incorrect to assume that there is enough play in the stay connection to let the head take its full share before the stay begins to take any of the load.

S. U. TUSPIN.

New York City.

Internal Feed Pipe Scaled Up

We have had considerable trouble with feed-water pipes stopping up with scale inside of the boilers. In fact, on one occasion it caused a shutdown.

We have one feed pump and two 1½-in. injectors for emergency service, but all are connected to the same inlet. The pump broke down one night and I tried the injectors in vain, the water getting lower in the glass every minute and no way of getting any into the boiler. Imagine how I felt, in an electric lighting and water plant too, where power was needed continuously. I had to shut down for two hours till I could get steam up in another boiler. To prevent a recurrence of this trouble, I put a tee on the end of the internal feed pipe, with a pipe projecting to each side of the boiler, making an outlet two ways and two 1½-in. discharge openings instead of one. It is still inclined to clog up just at the end, but we have never had any serious trouble with it since.

R. A. WILLIAMS.

Manassas, Va.

Lap on Corliss Engine Valves

In the July 23 issue of *Power* there appeared, under "Inquiries of General Interest," the question, "What are the reasons for putting lap on the valves of a Corliss engine?" This topic suggests the following discussion:

In the minds of some engineers there seems to be confusion between lap and seal. Lap is the amount by which the valve covers the working edge of the port when the wristplate is in midposition (the latch on the steam

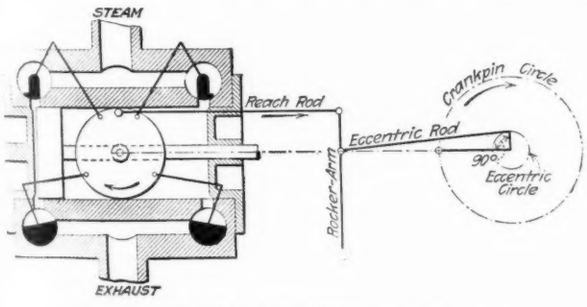


FIG. 1. VALVES WITHOUT LAP OR LEAD

bell-crank being engaged with the block on the steam arm in the case of the steam valves). Seal is the amount by which the valve covers the working edge of the port when in its extreme closed position (the latch being released in the case of the steam valves). It does not necessarily follow that a valve with a big lap will have a big seal nor does a valve having a large seal necessarily have a large lap.

The purpose of lap in a Corliss engine is the same as that in a simple slide-valve engine, and in fact if the steam arms remained hooked up all the time, the valves in a Corliss engine would move exactly as the valve of a slide-valve engine with the exception that the motion is distorted by the wristplate, the valves moving faster during some parts of their travel than during others. This is the purpose of the wristplate, and when properly proportioned a Corliss valve gear will open the valves quickly and allow them to remain practically at rest during the greater part of the stroke.

Fig. 1 is a rough sketch of a Corliss engine, the valves of which have neither lap nor lead and the eccentric has no angular advance. In the position shown, the piston is on the head-end center and the wristplate, rocker-arm and eccentric are in midposition. The working edges of the steam and exhaust valves are line and line with the edges of their respective ports. There can be no compression because the exhaust valves cannot close before the end of the stroke is reached.

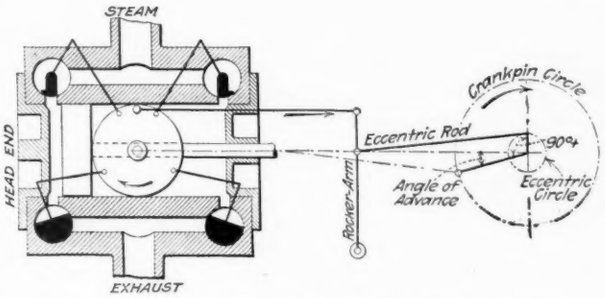


FIG. 2. LAP ADDED TO EXHAUST VALVES AND ECCENTRIC ADVANCED

Compression can be secured either by advancing the eccentric or by adding lap to the exhaust valves. Advancing the eccentric will cause the exhaust valve in the head end, Fig. 1, to close somewhat before the piston reaches the head-end center, trapping the remaining steam in the cylinder and causing compression. Also the crank-end exhaust valve will open before the piston reaches the end of its stroke, causing release to occur. With no lap on the exhaust valves, evidently release and compression occur simultaneously, when the wristplate is in midposition, since then the exhaust valves are line and line with their ports. If it is desired so to design the engine that release and compression do not occur simultaneously, it will be necessary to add a certain amount of lap to the exhaust valves.

For instance, Fig. 2 shows the Corliss engine of Fig. 1 with lap added to the exhaust valves and the eccentric advanced. Evidently the head-end exhaust valve closed some time before the piston reached the position shown, causing compression, and the crank-end exhaust valve has not yet opened, hence release has not yet occurred. Release and compression then do not occur simultaneously, but compression takes place before release. If it is desired to have release occur before compression, the exhaust lap must be negative; that is, with the wristplate in midposition the exhaust valves must stand open.

Thus far the exhaust valves only have been considered and it has been decided that to secure compression, the eccentric must be advanced and exhaust lap may or may not be necessary, depending upon the points at which release and compression are desired.

Advancing the eccentric will cause the head-end steam valve to open at some point before that shown in Fig. 1. The amount by which the steam valve is open when the piston reaches dead-center is the lead. With no lap

on the steam valves it is found that by using an angular advance suitable to the proper adjustment of the exhaust valves, the steam lead is excessive. To reduce this lead and retard the opening of the inlet valves, after advancing the eccentric, it is necessary to add lap to the steam valves. This is the purpose of steam lap in a Corliss engine. If the steam valves were closed positively by means of the steam links, the addition of steam lap would also cause an early cutoff. However, in the simple Corliss engine, cutoff is controlled by the knock-off mechanism and is dependent upon the speed of the engine. H. F. GAUSS.

St. Louis, Mo.

Operating and Repair Orders

To insure that operating and repair orders are understood so as to be carried out properly, I have found that giving written orders bearing the date, the operator's name and title and describing the work to be done, gives excellent results.

A small blank scratch pad or book with a carbon sheet to make an exact duplicate copy of the order furnishes an indisputable record, from which there can be no "dodging." A set of pigeonholes or mail boxes bearing the names of the operators or different department heads can be located conveniently so that each employee can look there for his instructions concerning the work.

Canton, Ohio. T. M. STERLING.

Cleaning Surface Condensers

Where the circulating water contains scale-forming matter, as it does in most localities, the cleaning of the condensers is governed by the amount of scale or deposit, the interval of time elapsing between cleaning and the length of time allowed for cleaning. When the time is short and the scale or deposit is slight, I have found that a solution of one part commercial muriatic acid and four parts water is an excellent medium for cutting out the deposit.

After cutting out the condenser, thoroughly test it for leaks by filling the steam space with water or by means of the vacuum pump. After all leaky tubes and packing ferrules are made tight, close off the inlet and discharge, and after providing ample vents on both ends of the water space and a steam connection somewhere on the bottom, allow the solution to run in slowly from a barrel above the condenser until the condenser is full, then turn on steam enough to cause the solution to boil slowly. The vents allow the gases to pass off and prevent the accumulation of undue pressure in the water space. The heat of the steam assists the acid in its action and should be kept on as long as possible, and upon draining it will be found that the tubes are as clean as new. If part of the circulating water is used in the boiler feed, it is advisable to flush out the water space to the sewer before putting the condenser in operation.

To clean the steam space of grease or sludge coming from the exhaust steam, fill the space with a strong solution of soda ash or caustic soda and water. (The strength of the solution should be governed by what it will take to cut the grease.) See that the steam space is also properly vented as before and turn on steam and leave it on as long as possible. Be sure to flush out thoroughly with clear water, if the condensate is used in the boiler supply, before starting. Where the deposit in the water space is hard, a reliable air or water turbine drill is a good means of doing the cleaning. T. M. STERLING.

Canton, Ohio.

Better Cylinder-Oil Testing Methods Are Needed

I am frequently asked to test steam-cylinder oils for lubricating properties, but unfortunately, I know of no good method of testing such oils outside of the cylinders in which they are to be used. But using the engines that we wish to save by good oils, like guinea pigs, for experimentation looks wrong. The various companies refining and selling cylinder oil seem to know no other way any more than I do. They all suggest the same thing; namely, to turn the plant over to them for experiments and to let them, by some mysterious process, discover the best lubricant for the case in question. Some go so far as to say that they will use tissue paper to determine whether or not the surfaces are properly lubricated, but there the science seems to end.

Now, it appears to me that this is a splendid field for discussion in *Power*. With so many operating engineers among its readers, there should be many with good ideas and methods of testing cylinder oils outside of the cylinder in which the oil is to be finally used. By outside tests I do not mean tests for viscosity, flash point, specific gravity and acidity, but some other tests which will tell what the oil will do inside of a steam cylinder. Could *Power* by some "editorial wand-waving" get the discussion started? I am sure that many readers would take part and all would be benefited thereby. W. TRINKS,

Professor of Mechanical Engineering,

Pittsburgh, Penn. Carnegie Institute.

Use of Exhaust-Steam Injectors

As a result of the article in the issue of Oct. 8, page 521, suggesting the use of exhaust-steam injectors where there is exhaust steam being wasted, we have received several letters of inquiry—who the manufacturers are and the degree of satisfaction in their practical use, etc. We shall be pleased to publish the names of the manufacturers for the benefit of our readers and also letters from anyone who has had experience with such injectors. We understand that some have discontinued the manufacture of this line as unprofitable, and it is therefore possible that they have disappeared entirely from the market. Let us hear from those who have used them.—Editor.

In *La Revue Générale de l'Electricité* as reported in *Indian Engineer* (Bombay), Dr. Chorower gives particulars of the results of researches which he has conducted on the subject of the corrosion of turbine blades. He finds that this action is traceable to the presence of carbon dioxide in the steam, derived from the boiler feed water. He advocates the elimination of carbonates from the water by chemical purification.

INQUIRIES OF GENERAL INTEREST

Putting Down Concrete Foundations in Cold Weather—Can good foundations of cement and broken-stone concrete be built suitable for engines and machinery while the work is exposed to freezing cold weather? J. H. L.

The earth bottoms of excavations for receiving the foundations should be free from frost. Freezing retards the setting of portland-cement concrete and lowers its strength for a short period, but the ultimate strength and hardness are not seriously affected, although the surface finish, when placed in freezing weather, is likely to scale off. Setting can be hastened and action of frost retarded by warming the materials, or by adding 5 to 10 per cent. of salt to the weight of water used in mixing the concrete.

Moderate Slippage of Joint Not Sign of Weakness—What causes slippage of a rivet joint of a boiler shell, and is slippage a sign of weakening of the joint? E. L. G.

Although a rivet when set hot by either hand or machine riveting may completely fill its hole, upon cooling it contracts and does not fill the hole completely. Hence the shearing resistance of a rivet does not come into play until the plates have slipped, one over the other, sufficiently for the rivet to come to a bearing. If the holes are uniform in size, the rivets offer uniform resistance, and with a moderate amount of slippage the only indication of weakness is that the friction between the plates is not sufficient to prevent slippage. In standard American boiler practice no reliance is placed on the resistance to slippage, as it depends on the uncertain friction between the plates due to the longitudinal holding power of the rivets.

Increasing Back Pressure for Exhaust-Steam Heating—The average load of an 18 x 36-in. Corliss engine requires 52 lb. m.e.p., cutoff occurs at about one-third of the stroke, and there is 2½ lb. back pressure, but to supply exhaust steam to the heating apparatus of the building in which the engine is situated requires 6 lb. back pressure. How much more steam must be supplied to the engine for the average load when exhaust is supplied for heating? B. N.

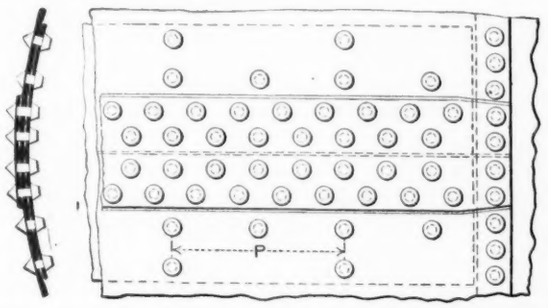
If the heating apparatus is so arranged and operated as to require the additional back pressure on the engine, considering back pressure in each case as the average back pressure during the whole return stroke of the piston, then for the same average load the 6 lb. back pressure would require practically the same length of cutoff as 52 + (6 — 2½) = 55½ lb. m.e.p. would require with 2½ lb. back pressure. For small variations of load the steam consumption would be approximately in proportion to the load, and the increase of 3½ lb. back pressure should increase the steam consumption of the engine about 3½ × 100 ÷ 52 = 6.7 per cent.

Trouble from Airbound Pipe Lines—How can the pipe line of a gravity water supply be prevented from becoming airbound? M. W.

Water obtained from natural sources of supply contains air that is relieved by sudden reduction of the pressure, such as at bends and variations in size of a pipe line, and also at crests in the line. The gathering of air due to churning action from irregularity of flow is preventable only by the employment of easy bends and more gradual variations of size of the pipe line. In most cases the greatest trouble comes from accumulation of air at high points, especially when there is a siphon-like discharge over a crest in the line. The trouble can be removed by an air vent at the highest point. Automatic air valves are made for this purpose, though their use is generally confined to large pipe lines like those used for municipal water supplies. Equally good results can be obtained with an open air vent connected to a small standpipe raised to a higher level than the source of the water supply; or as only a very small vent opening is necessary, it may be allowed to remain open continuously without entailing serious loss of water.

Efficiency of Quadruple Riveted Joint—What is the efficiency of a quadruple-riveted butt and double-strap joint in which the main plates are $\frac{17}{32}$ in. thick and butt straps ½ in. thick, each of 55,000 T.S. and 95,000 lb. crushing strength, with 16-in. pitch of rivets of the outer row, diameter of rivet holes 1 in., and shearing strength of rivets 44,000 lb. per sq.in. single shear and 88,000 lb. in double shear? W. R. A.

Having rivet holes 1 in. diameter, the cross-sectional area of rivets after driving would be 0.7854 sq.in., and for a



BUTT AND DOUBLE STRAP JOINT, QUADRUPLE-RIVETED

unit of pitch, P in the sketch, there would be three rivets in single shear and eight rivets in double shear. As the main plates are $\frac{17}{32}$, or 0.53125 in. thick, for a unit length of joint P there would be

(A) Strength of solid plate = 16 × 0.53125 × 55,000 = 467,500.

The strength of the joint per unit of length P would depend on the least value obtained from the following considerations:

(B) Strength of plate between rivet holes in the outer row = (16 — 1) × 0.53125 × 55,000 = 438,281.

(C) Shearing strength of eight rivets in double shear, plus the shearing strength of three rivets in single shear = (8 × 88,000 × 0.7854) + (3 × 44,000 × 0.7854) = 656,594.

(D) Strength of plate between rivet holes in the second row, plus the shearing strength of one rivet in single shear in the outer row = [[16 — (2 × 1)] 0.53125 × 55,000] + (1 × 44,000 × 0.7854) = 443,620.

(E) Strength of plate between rivet holes in the third row, plus the shearing strength of two rivets in the second row, in single shear, and one rivet in single shear in the outer row = [[16 — (4 × 1)] 0.53125 × 55,000] + (3 × 44,000 × 0.7854) = 454,298.

(F) Strength of plate between rivet holes in the second row, plus the crushing strength of butt strap in front of one rivet in the outer row = [[16 — (2 × 1)] 0.53125 × 55,000] + (1× 0.5 × 95,000) = 456,562.

(G) Strength of plate between rivet holes in the third row, plus the crushing strength of butt strap in front of two rivets in the second row and one rivet in the outer row = [[16 — (4 × 1)] 0.53125 × 55,000] + (3 × 1 × 0.5 × 95,000) = 492,125.

(H) Crushing strength of plate in front of eight rivets, plus the crushing strength of butt strap in front of three rivets = (8 × 1 × 0.53125 × 95,000) + (3 × 1 × 0.5 × 95,000) = 546,250.

(I) Crushing strength of plate in front of eight rivets, plus the shearing strength in single shear of two rivets in the second row and of one rivet in the outer row = (8 × 1 × 0.53125 × 95,000) + (3 × 44,000 × 0.7854) = 507,423.

As the least strength is found from consideration (B) the efficiency is $\frac{B}{A} = \frac{438,281}{467,500} = 93.7$ per cent.

Dr. Mann's Report on Engineering Education

For more than three years Dr. Charles R. Mann has been making a study of engineering education, under the joint auspices of the Carnegie Foundation for the Advancement of Teaching and the Joint Committee on Engineering Education of the national engineering societies. This article is a very brief abstract of his voluminous report

ENGINEERING education in its primary conception is a means by which production can be increased. This dominates the comprehensive report Dr. Charles R. Mann has just made on engineering education. From that principle he argues that knowledge of the human factor in production is as important as that of materials; and his investigation indicates that engineering schools treat of materials extensively but not of the human element. He also finds a need for much more instruction in the appraising of values and costs. What he proposes is not a standard curriculum, but a method by which engineering schools can construct courses to meet present-day demands, coupled with a more rational means of testing and grading the abilities of the students before admission and throughout the courses, thus directing them with greater certainty to the specialty for which they are best fitted.

Common Core for All Engineering Courses

The method he proposes for the actual formulation of the courses is to have in each school a standing committee which shall decide what he calls the "common core" of all engineering education, no matter what the specialty. This "core" being defined with reference to the needs of the engineer, the committee would determine the time necessary to cover it adequately and would shape the courses accordingly, instead of arbitrarily parceling off to the different department the time predetermined as available and letting each department crowd as much as possible into its allotted time.

The curricula and methods of instruction that were devised to supply the intellectual element in production by imparting knowledge of natural science must be reorganized to meet the new industrial demand for engineering administrators and the larger professional demand for men of strong personality. The general plan of the proposed reorganization is based upon an analysis of engineering practice into its three essential factors—knowledge of engineering science, skill in technique of application and judgment in the appraisement of values and costs. In every engineering project the overlapping claims of these three essential factors must be harmonized with respect to materials and men, the two fundamental elements of production. Every engineer should have some conception of the present conditions and problems in at least the general aspects of all these essential factors and elements. If this is granted, it is easy for any school to discover where its curriculum is overloaded and where it is deficient.

Scientific Knowledge Lacks Coördination

This analysis also indicates how the present organization of school work can be modified so as to furnish a more vital training for professional engineers. Thus, the schools do give careful instruction in the laws of physical science and in the properties and uses of materials. Students are taught the relative strengths of substances in the materials laboratory, kinematics teaches the principles of gearing, the shapes of gear-teeth are worked out in the drawing room, the chemical properties are taught in chemistry, mechanics deals with the forces required to overcome inertia, machine work is relegated to the shop, and so on. But seldom is all this information coördinated in a single practical problem, such as determining whether mild steel, nickel steel or phosphor bronze is the best thing to use in making a particular gear wheel; nor is the student ever asked to judge what combination is likely to produce the most valuable result for the price. Yet this balancing of value and cost is the controlling factor in all intelligent production.

With regard to the second element of production—men—most schools at present are doing practically nothing to arouse the students to an intelligent appreciation of the problems of personal and human relations in production. Yet these problems are every day becoming more acute, as indicated by such movements as Americanization, human engineering, industrial engineering and scientific management, with their various efforts to improve the condition of the workman and to increase his output in production. Many of the burning questions of the time lie in this field.

Contact with Labor and Workmen Needed

The training of men for the solution of these human problems cannot be carried out in the schoolroom alone. The students must have some vital, first-hand, personal contact with labor and workmen's conditions, either by a coöperative system, as at the Universities of Cincinnati and of Pittsburgh, or through the industrial-service movement, or in some other real and living way. Hence, meeting this demand requires some form of closer coöperation between the engineering school and the industries, better understanding of their mutual relations, and willingness on both sides to approach the problem with the true research spirit. Such coöperation is needed not only to give the students a vital conception of the workman's point of view, but also to furnish that intimate personal knowledge of the details of production which cannot be secured in college laboratories and shops. The lack of this sense of the physical properties of materials is one of the chief reasons why less than 5 per cent. of the production managers in this country are college-trained men.

It is, however, in the matter of estimating values and costs that this problem assumes its most far-reaching consequences. The following are some of the typical problems now pressing for solution in this field: What is the effect of good housing on the development of the men, the efficiency of production and the size of the profits? What is the most effective incentive to maximum output—the bonus system? opportunity for coöperation in management? opportunity for creative work? or shorter hours? Does the assurance of justice and a square deal always tend to increase output and also to foster the growth of a social spirit and of patriotism? Does a plant pay better when profits and output are increased by efficiency methods which give workmen no chance for self-expression, or when the development of the workmen is made an aim as well?

Every manager will estimate the values and costs of these various methods of treating workmen in accordance with his own philosophy of life. There is as yet no conclusive evidence to prove these cases one way or the other. The successful manager today is the one who estimates most accurately the human values involved. Therefore, one of the most important contributions that the school can make toward the education of the engineer is to guide him in developing an attitude toward life and a philosophy of living that will enable him to judge rightly as to the things humanity considers most worth while. This is the meaning of the professional demand for larger opportunities for cultural and literary studies. It cannot be met by merely requiring more work of the ordinary academic type in history, in economics and in languages; but rather by introducing the consideration of values and costs into the regular engineering instruction.

Making Work Seem Worth While

One of the most effective ways of making work seem worth while is by constantly relating it to the consideration of the whole range of values involved and all the costs. Every decision in daily life is an answer to the question whether the value is worth the cost. The omission of this mainspring of all investigation and inquiry from school work is perhaps the chief reason for the chasm that separates the schools from life. Hence the first message of the profession to the schools is: Motivate your work by making

it worth while; liberate the spirit of investigation by making the game worth the candle; for character, judgment, efficiency and understanding of men develop best in men who work with enthusiasm and intelligence at things that they believe to be worth while.

Discussing the problems of engineering education, as he sees them, Dr. Mann says it is evident that when 60 out of every 100 of those admitted fail to continue through the course, the present systems of admission, whether by examination or by certificate, are not satisfactory. Obviously, a fairly large number of students who ought not to try to become engineers are permitted to undertake studies for which they have little natural ability.

He does not point to any tests yet worked out as a final solution of the college-entrance problem, but he feels that when the colleges are able to define their admission requirements in terms of abilities, as measured by objective tests, instead of in terms of subject matter covered, it may be possible to lift the incubus of ignorance that now oppresses the secondary schools, to supply the colleges with freshmen much better trained and sorted on the basis of ability, and to reduce the mortality of 60 per cent. to a more reasonable figure.

Shopwork in Engineering Education

Shopwork forms the last of Dr. Mann's problems of engineering education. He points out that in American technical schools shopwork is seldom recognized as being of university grade. Yet no one denies that it is an essential element in the equipment of every engineer; and therefore it has been tolerated by engineering faculties and allowed to develop as best it could. As a result there is no agreement as to the purposes and methods of shopwork. Nearly every school has a shop philosophy and a well-organized shop method of its own.

The purpose of shopwork he conceives to be an aid in bringing to the student a conception of what is meant by production and what are its fundamental problems. Numerous forms of shopwork, as conducted by the schools, are described by Dr. Mann, but he gives most attention to the coöperative plan in operation at the University of Cincinnati, inaugurated by Dean Herman Schneider.

The students at the University of Cincinnati are divided into two groups, one of which is assigned to work in industrial plants while the other goes to school. At the end of each biweekly period the two groups change places, so that the shops and the school are always fully manned In the shops the students work as regular workmen for pay, but the nature of their work and the length of time each stays on any particular job are subject to approval by the university.

The money earned during shop periods makes possible an engineering education to many a boy who could not otherwise afford it. In addition to the financial advantage, however, the work has three marked points of superiority over that done in college shops: (1) It is real commercial production that must succeed or fail on its merits; (2) the variety is much greater than is possible in any college shop; (3) the student is thrown in personal touch with workmen, thus coming to know their point of view in a sympathetic way, and securing a conception of the human problems of industry and the appraisement of human values and costs that cannot be acquired so well in any other way.

Human Values and Costs Must Be Included

The difficulty in present school practice evidently lies in the exclusion from the technical work of all consideration of the question of human values and costs; and, conversely, the isolation of the humanistic studies from all technical interest. But experiments show that technical work is more impelling and is, therefore, more fully mastered when it includes the consideration of values and costs; while humanistic work becomes significant, and therefore educative, when it starts from and builds upon the professional interest.

The first step toward successful specialization is intelligent sorting of the students so that each is led as definitely as possible into that type of work for which he is best fitted temperamentally. This requires that while the students are working through the "common core" every effort be made to discover the particular abilities and specific bent of each, not only by means of ordinary examinations and academic grading, but also through objective tests of graded ability, personality estimates by members of the faculty, consideration of boyhood interests, and observations of each student's reactions to the different portions of the "common core." The work in the latter offers an excellent chance for vocational guidance.

To summarize, the plan of curriculum proposed differs from curricula as at present constituted in seven important ways:

1. The subject matter essential to the equipment of the engineer determines the time schedule, instead of arbitrary time limits determining the amount of this subject matter that can be given.
2. The proposed plan calls for the student's participation in real industrial work and the utilization of his experience there as a source of problems for the classroom.
3. Engineering laboratory work is proposed for the first two or three years instead of in the last years.
4. Close coördination is required between the scientific courses of the "common core" and the practical work.
5. Emphasis is laid on the problems of values and costs.
6. For short independent courses in the technique of composition, literature, history, economics and so on are substituted humanistic studies extended into a consecutive course carried through the entire curriculum and consisting of live discussions and study of the best that has been thought and said concerning the immediate and the ultimate values in life.
7. Specialization is subordinated to vocational guidance. Because the "common core" gives a student a chance to choose his specialty on the basis of experience, and furnishes the faculty with a broader range of activities on which to base judgment of special aptitudes for particular work, the attention of the faculty is diverted from the construction of specialized grooves down which the student may be shoved by routine administrative mechanisms, to the study of the personalities, the temperaments and the capacities of young men eager to do the work for which they are best fitted.

Survey Parties Needed by Construction Division of the Army

The Construction Division of the Army is without doubt the most colossal organization of its kind in the history of the world. The approximate value of construction projects so far undertaken by this branch of the Government is one billion dollars. The figures representing the material used and the men employed are staggering; 250,000 workmen have been under the control of the division at one time.

Among the division's present urgent needs are 50 chiefs of survey party at $2700 to $3000 a year; 50 transitmen at $2400 a year; 25 levelmen at $2100 a year; 125 rodmen at $1800 a year; 150 chainmen at $1800 a year, and 50 topographic draftsmen at $2100 a year. These positions are open to men only, except the drafting positions, which are available to both men and women. All the positions are in the civil, not the military, service.

Persons interested should apply to the United States Civil Service Commission, Washington, D. C., or to the secretary of the local board of civil service examiners at Boston, New York, Philadelphia, Atlanta, Cincinnati, Chicago, St. Paul, St. Louis, New Orleans, Seattle or San Francisco.

Applicants will not be required to undergo a written examination, the examination being of the "nonassembled" type; that is, the ratings will be based upon education, training, experience and physical ability as shown by the applications and corroborative evidence. These positions offer an excellent opportunity for patriotic service, and the Commission urges qualified persons to apply without delay.

Glenn H. Curtiss is the inventor and has also been the builder of the finest seaplanes ever produced, as both the British and American navies are testifying today by the numbers of them they have in use.

Liability in Case of Boiler Explosions

By CHESLA C. SHERLOCK

ALTHOUGH there are numerous safety devices in use for the protection of employees operating machinery, accidents are almost certain to occur from time to time. This is markedly true in the use of steam engines and boilers.

Boilers are now so built that their explosions are not caused so much by defective construction as by the possible condition of the safety devices used upon them with a view of lessening or preventing the explosion of the boiler itself.

When boilers were run largely by guesswork, there was a certain percentage of mistakes resulting in accidents. A workman might be guilty of poor judgment or of indifference or of criminal negligence, which might result in disaster. The situation is the same where devices have become defective and allowed to operate as a boiler-protective measure.

If a workman relies upon a defective gage which he does not know is defective and has had no opportunity of discovering the defect, he may carry an excessive pressure and get into difficulty. On the other hand, if he knows that the gage is defective but has determined in his own mind the relative lay of the pointer with a correct gage, he is likewise liable to make an error in judgment and overpressure his boiler, all of which may have a disastrous result.

Questions of this and a similar nature are continually coming before the courts for solution. Is the error of judgment made by an employee, in good faith, such a breach of the duties of his employment, as to deprive him of recovery in case of injury? Or is the failure of the employer to properly inspect and test his device so as to prevent employees making such errors of judgment so vital in the matter as to permit recovery, regardless of the conduct of the workman?

A Kentucky case brought up a nice point of law. The boiler that exploded and caused the death of the plaintiff's intestate was equipped with a water glass and three water cocks. The water glass was in a defective condition, having been broken for some time prior to the accident. The deceased had notified the defendant's foreman of this fact, and the foreman had promised to have a new water glass installed. In fact, he had directed an employee to install this new water glass and this employee was at the boiler working on it at the time the explosion occurred.

The plaintiff contended that the employer was guilty of negligence because of the defective condition of the water glass at the time of the explosion. The defendant, in turn, claimed that the deceased had been guilty of negligence because of a failure to test the water cocks and ascertain the height of the water in the boiler. The defendant also claimed that the explosion was due to an inadequate supply of water in the boiler.

The court naturally submitted these questions to the jury, holding that it was a question of fact for the jury to decide whether the explosion was due to the defective condition of the water glass or to the insufficient supply of water in the boiler.

The court instructed the jury that it was the duty of the defendant to equip the boiler with a water glass and further gave instruction concerning the liability of the defendant for its failure to have a water glass on the boiler. The court did not pause here, but instructed the jury that if the explosion was caused by an insufficient supply of water, due to the negligence of the deceased, there could be no recovery.

The jury found, as a matter of fact, that the explosion was caused by the defective water glass and gave a verdict of $2000 for the plaintiff, which the court affirmed.

In a Massachusetts case the question of safety valves was brought up. It seems that two workmen were engaged in the duties of their employment in the basement of the employer's establishment, where was located a copper boiler which exploded.

The plaintiffs claimed that the explosion was due to a safety valve on the boiler which defendant used in a negligent way, particularly as to the manner of adjustment and operation. The defendant contended that the safety valve was entirely unnecessary and that it had nothing whatever to do with the explosion.

The court held that "in view of the relative size and capacity of the boiler and heater, the existence of the stop-cock by which the water from the street mains at any time could be shut off, the liability to such an occurrence, the general arrangement of the boiler to the whole somewhat complicated apparatus, and of the number of persons in the employ of the defendant, together with their lack of technical knowledge of the apparatus, the question of whether the safety valve was reasonably necessary, whether it was kept in a proper condition, and whether, if it had been so kept, the explosion would have been prevented even if the stop-cock was closed, were for the jury."

The jury gave a verdict for the plaintiffs and when the defendants took exception to this verdict, their objections were overruled by the court.

In an Illinois case a workman was killed by the bursting of a boiler which he was operating under 75 lb. steam pressure. The evidence showed that there was a certificate hanging on the wall of the engine room that the boilers had all been inspected by the city inspector and that they would safely carry 75 lb. pressure. It was further shown that the boilers were habitually operated under a pressure of from 65 to 75 lb. pressure and that they had been so operated every day during the term of the deceased's employment.

The evidence disclosed a further fact which had a very important bearing upon the case. It was to the effect that one of the boilers, in fact the one which had exploded, was more than twenty years of age. The explosion revealed several defects in the boiler which were doubtless due to its age.

The negligence charged was that the boiler was in a defective condition; that the defendants failed to use reasonable care to provide the plaintiff's intestate with a reasonably safe place in which to work and to inspect the boiler, and it was also alleged that they were chargeable with knowledge of its defective condition and that the deceased had no knowledge or equal means of knowledge of such defect.

In the course of the trial the fact was brought out that one engineer had claimed that the boiler was dangerous because of its age and that he had quit work on that account. The deceased was not aware of this fact.

The jury gave a judgment for $10,000, which the defendants appealed, relying upon the question of whether the duty of inspection rested with the employer or with the employees. It was also contended that the duty of inspection was a necessary part of the engineer's work, that he assumed the risk of injury therefrom, and that he was guilty of negligence in failing to make such tests as would have disclosed the weakness of the boiler.

The court held that the duty of inspection rested with the employer and that the employee had the right to assume from the employer's direction to start work and the official inspection certificate upon the wall, that due care had been exercised by the employers to furnish a safe boiler. The employee did not assume the risk of injury by failing to test the boiler for defects when none was apparent.

In a Tennessee case the plaintiff was employed in the defendant's sawmill and it was his duty to take care of a certain boiler, which exploded and caused the injury for which damages were sought.

It was shown that the boiler was very old, that it had been in use for more than forty years, and that in the explosion it had burst into four parts and that after the explosion a rusted rivet had been found.

After the courts had thrown the case back and forth, it finally reached the Supreme Court, where it was held that the fact that a rusted rivet had been found seemed to indicate that such rivets were inadequate and unable to with-

stand the pressure necessary on a boiler of that type, at least that they could not withstand the pressure that good rivets would. The court said that the jury might reasonably infer from the fact that these rivets were rusted that they were inadequate. It further reversed the judgment of the court, which had been against the defendant.

In a Washington case the plaintiff was injured by falling in attempting to escape from a boiler room where an explosion had just occurred, due to the defective condition of a blowoff pipe.

It was shown that the employer had failed to brick up around the blowoff pipe, thus causing the pipe to be exposed to the heat and flame of the fire, and although there was but slight evidence to support the allegations, it was held to be sufficient to sustain the charge of negligence where there was evidence from which it could have been found that the elbow of the pipe became defective after its installation, because of the length of heavy pipe hanging on it for support, the settling of the boilers, and the pipe, instead of having free access as it came through the wall, coming in contact with the wall, causing too heavy a strain upon the pipe, and there was some evidence that a brick protection around the elbow would be of value in protecting it against the heat and flame, and that the failure to so protect weakened the elbow and made it more susceptible to bursting or breaking. The judgment in favor of the plaintiff was affirmed.

In a Massachusetts case the plaintiff sued and obtained damages for the death of her husband due to the bonnet on a steam valve being blown off by escaping steam, while the decedent was employed as engineer in the boiler room of the defendant. It was shown that the steam valve had been repaired a few days before the accident and that it had been leaking; that it was the duty of the decedent in such cases to repair the defect.

It is presumed that the decedent had gone to repair the leaking valve, as his body, together with the tools necessary for such work, was found near the valve.

From this fact the inference could be drawn that he had gone behind the boiler before the explosion and could not have caused the accident by any careless act of his own, there being evidence that the pressure of escaping steam, if the bonnet had been blown off before he came there, would have been too great for him to have gone in at all, and if he had attempted to turn the nut the wrong way the escaping steam would have driven him away from the neighborhood.

While there was, of course, no direct evidence as to what he was doing at the time of the accident, the burden was upon the plaintiff to show that he was in the exercise of due care and there was sufficient evidence from which there was an inference that decedent was in the exercise of such due care.

Other cases might be given showing instances of the nature of those already mentioned, but they would serve no useful purpose. Suffice it to say that the cases upon this point are legion and they involve all the varying phases of a very interesting portion of the law of master and servant.

The liability of the master seems to be rather well defined, especially in those states having safety-appliance acts and other statutes touching the subject.

Emulsification of Mineral Lubricating Oils*

By P. H. CONRADSON

Chief Chemist, Galena Signal Oil Co., Franklin, Penn.

THE article describes a simple apparatus and test method to determine the emulsibility and demulsification (demulsification value) of lubricating oils such as steam-turbine, steam-engine and crank-case oils, which have been found to give satisfactory results in the writer's laboratory considered from a practical service standpoint.

The method is briefly as follows: Twenty cubic centimeters of distilled water and 100 c.c. of the oil to be tested are placed in a suitable cylinder. The mixture is churned by passing steam through it at ordinary pressure. The cylinder containing the mixture is then immersed for one hour in a water bath kept at a temperature of 130 deg. F., removed from the bath, and the contents are examined for: (1) the number of cubic centimeters of separated clear or turbid water; (2) the number of cubic centimeters of separated emulsified layer; (3) the number of cubic centimeters of separated clear or turbid oil above the emulsified layer; and (4) the percentage of water or moisture in the separated oil above the emulsified layer.

The number of cubic centimeters of clear or turbid oil above the emulsified layer, less the percentage of water or moisture contained in the oil, is the percentage of demulsibility of the oil.

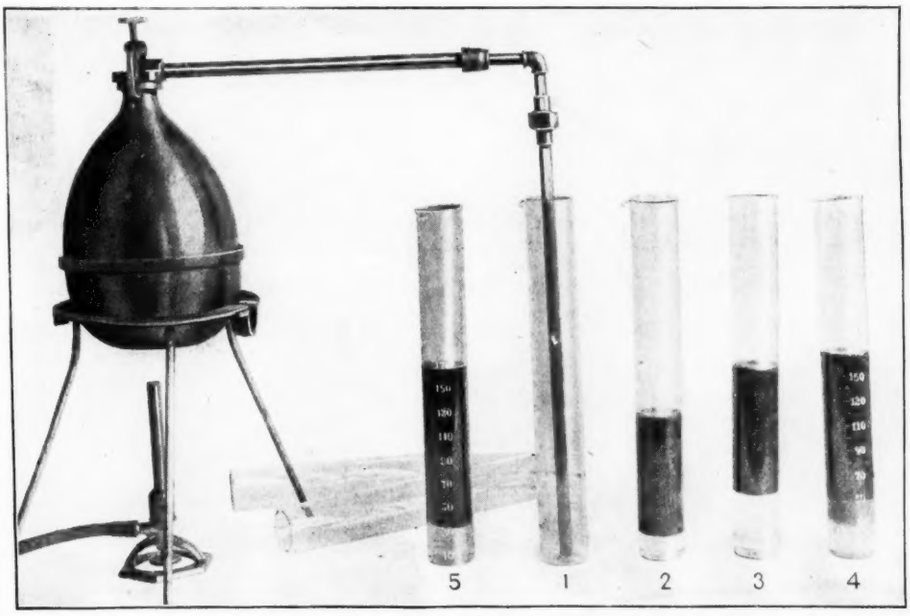


FIG. 1. OIL EMULSIFICATION TESTING APPARATUS

The method described gives in the majority of cases both the demulsification value and the emulsion-forming property of the oil, besides other valuable data in connection with so-called emulsifying tests.

Fig. 1 needs but little explanation. The apparatus consists of a 4-pint copper retort, provided with a delivery tube, which is joined to a metal or glass pipe having an inside diameter of about $\frac{5}{16}$ in. and about 15 in. long from the elbow. The lower end of this pipe is cut off diagonally to prevent thumping.

The glass cylinders are graduated to 250 c.c. They have an inside diameter of about $1\frac{7}{16}$ in. and a length of about

*From a paper before the American Society for Testing Materials.

9½ in. from the bottom to the 250-c.c. mark. They are 11½ to 12 in. over all, and are of thin glass, with a flat bottom.

In place of a copper retort for the generation of steam, a glass flask or any other suitable source of steam supply may be used; likewise, ordinary 250-c.c. graduated glass cylinders, of dimensions given, may be used where emulsion tests are required only occasionally.

The cylinder is filled with distilled water up to the 20-c.c. mark, then 100-c.c. of the oil to be tested is added. To churn the mixture, steam at ordinary pressure is conducted through this oil-water mixture for ten minutes. The amount of steam passed through is regulated in such a way as to prevent the mixture from splashing over the top of the cylinder, but the rate may be as rapid as is practical. This is easily regulated by the height of the gas flame.

The churning is begun from the time the temperature of the mixture has reached 200 deg. F., or when the steam as such passes off the mixture. It usually takes from 1 to 1½ min. to reach this temperature, depending somewhat on the body or viscosity of the oil. However, even churning with steam for 15 min. does not seem to make any difference in the results.

When the churning is completed, the cylinder is immersed for one hour in a water bath, kept at a temperature of 130 deg. F. During this time the cylinder and its contents are momentarily inspected at intervals to note the behavior of the oil mixture. At the expiration of one hour the cylinder is removed from the water bath and the contents are examined.

The amount of water held in the oil above the emulsified layer may be determined as follows:

The oil above the emulsified layer after the expiration of the test is carefully drawn off and shaken; then 20 c.c. is mixed with 80 c.c. of 88 deg. Bé. gasoline (from Pennsylvania crude) in a graduated, flat-glass precipitating tube having the lower end drawn out. The oil-gasoline mixture is kept at a temperature not over 80 deg. F. for one hour, or the water or watery liquid may be separated from the oil-gasoline mixture by means of a centrifuge. The amount of water or watery liquid is read off and calculated to percentage by volume and subtracted from the oil above the emulsified layer. Of course this determination is necessary only when the oil above the emulsified layer appears to contain an appreciable amount of water.

Fig. 2 illustrates the behavior of seven representative oils with this method as they appear after the expiration of tests. The table gives detailed results of tests of these oils. The first turbine oil shows the oil entirely free from emulsifying property or elements, only retaining a small percentage of moisture or water after the expiration of the test. The second turbine oil shows quite a little of emulsified layer, but the condition of the emulsified layer is light and foamy, not compact or creamy. The amount of water or moisture retained in the oil is much higher than in the first oil.

Consider next the two samples of crank-case oil: The first oil shows ready separation of water, which is clear and has no emulsified layer, but the oil after the test retains about 5 per cent. of water. With the other crank-case oil only a very few cubic centimeters of water are separated at the expiration of the test, and a large amount of emulsified layer of a heavy thick nature is shown; in fact, the whole mixture is a heavy emulsion without separation. The first sample of engine oil shows at the end of the test a thick milky emulsion with practically no separation of water, and the separated oil above the emulsified layer contains about 4 per cent. of water. The second sample of engine oil shows a considerable amount of separation of water and a much smaller amount of emulsified layer; this layer is of a light foamy nature.

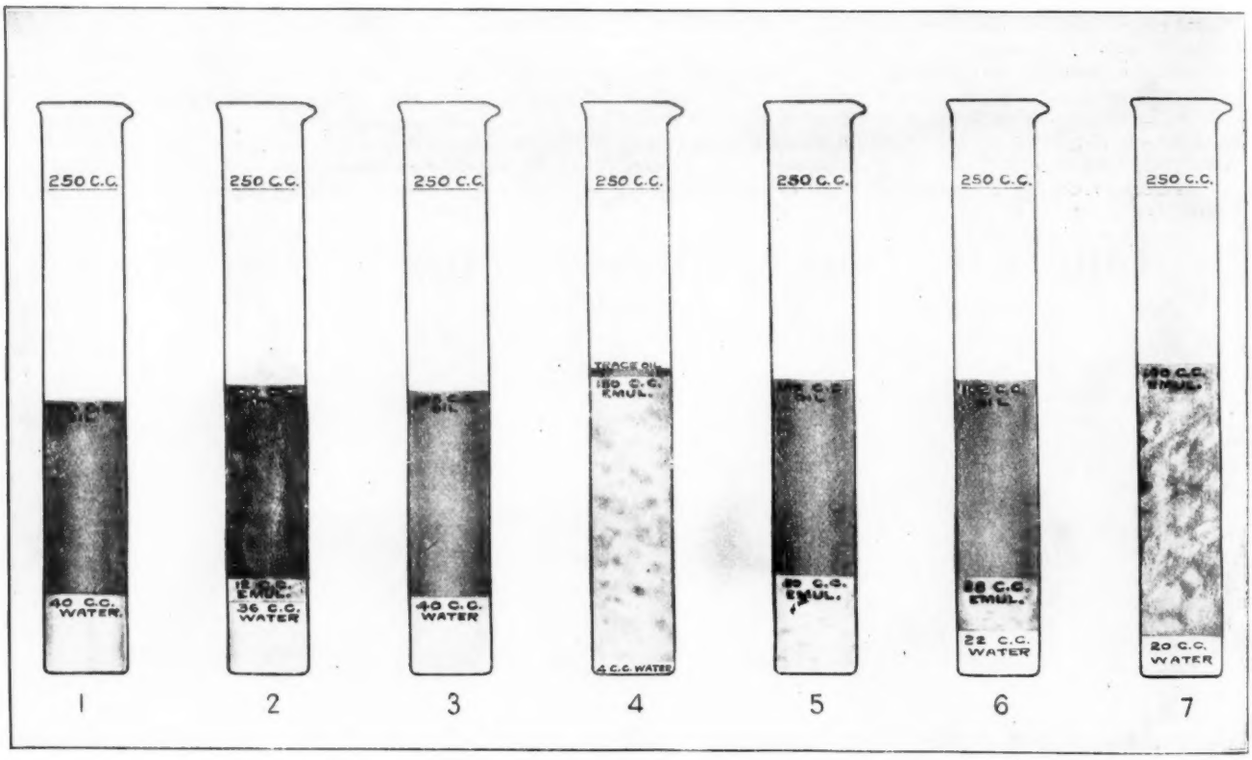


FIG. 2. REPRESENTATIVE LUBRICATING OILS AT EXPIRATION OF EMULSIFICATION TESTS

EMULSIFICATION TESTS OF LUBRICATING OILS

Oil No.	Kind of Oil	Separated Water, c.c.	Condition of Water	Emulsified Layer, c.c.	Kind of Emulsion	Separated Oil, c.c.	Condition of Oil	Moisture in Oil, Per Cent
1	Turbine	40	Clear	None	.....	100	Slightly turbid	0.2
2	Turbine	36	Slightly turbid	12	Light foamy	100	Turbid	1.0
3	Crank case	40	Clear	None	.....	105	Very turbid	5.0
4	Crank case	4	Clear	150	Heavy thick	Trace	Practically all emulsion	....
5	Engine	None	.....	50	Thick milky	102	Very turbid	4.0
6	Engine	22	Clear	28	Light foamy	102	Turbid	3.0
7	Spindle	20	Milky	140	Thick milky	None	All emulsion	..

Automatic Engine Stops*

By WALTER GREENWOOD

AUTOMATIC engine stops perform a distinct office from that of any control apparatus for an engine; they are intended to stop an engine when the control apparatus fails to prevent overspeeding. Notwithstanding the kind of valve and operating equipment that comprises an automatic stop, which is considered the best that can be procured by those responsible for the installation of them, some fail, and each failure in some measure destroys confidence as to the worth of any make or method, however reliable it may be. The assertion has been made by someone, that "accounts of comparatively few flywheel explosions find their way into the press, and that such accidents are occurring at the rate of about twelve a month. Furthermore, authority asserts that there are 33 per cent. more flywheel explosions than boiler explosions, and they are 50 per cent. more costly."

There is one supreme principle involved that should always be kept in view; that is, failure from any cause of any part of the installation must result in the stop performing its office, regardless of resultant production loss or any inconvenience. These considerations, namely, loss and inconvenience, are the drawbacks, in too many cases, that interfere with making installations of stops as nearly perfect as human minds can conceive. The most important mechanical principles involved in the construction of automatic engine stops are quick and positive response to increase of engine speed by that part of the mechanism which makes the initial movement, which can be determined within narrow limits; quick and positive response of the other parts, to contact with the first part brought into action.

Centrifugal Force as Operating Agency

Automatic engine stops have been known to fail in the performance of the office they were designed for, because of failure of the agency actuated by centrifugal force to release the static energy held in suspense for bringing a valve into operation, through direct or indirect application of force. Applications through rope, bar or shaft would be direct; through the agency of electric current would be indirect. With whatever design of mechanism employed by principal makers of engine stops, centrifugal force is the prime actuating medium. The agency through which it directly acts, usually a solid of high density, may be located on or in the rim of a flywheel, or a collar attached to a shaft, or on any revolving part where peripheral speed synchronizes with the speed of the engine. It may be indirectly brought into action through a flywheel governor driven by a belt from a revolving part that moves in synchronism with the speed of the engine.

In the list of failures are cases where connecting pins, placed in the rims of flywheels and actuated by centrifugal force, became rusty or accumulated matter around them and in the spring for limiting their projection; also from disarrangement of springs that prevented compression or extension. In other cases the same causes that prevented the action of controllers, accumulation of nonvolatile matter, oxidation of metallic parts, pressure of packing, etc., have been the cause of failures. There is not one of these causes but that could have been discovered and guarded against by systematic inspection and proper construction. Connecting pins placed in the rims of flywheels should be carefully constructed, both spring and pin a loose fit yet not excessively loose. The pocket for the spring should be so large that the spring will be free when at the point of utmost compression. Spiral springs should be so coiled that the utmost compression they are liable to be subjected to will not bring the coils together. Periodically spring and pin should be cleaned and oiled.

The shut-off valve of an automatic stop should be so perfect that it cannot fail to close when released. Probably failure from this cause has done more to shake confidence in automatic stops than any other kind of failure. As all these valves must have exterior connection to their shafts or stems such shafts or stems must pass through packing or have a collar that will seat on a bearing to prevent escape of steam. A stem that moves longitudinally is very liable to stick from causes previously enumerated. None but metallic packing should be used to pack valve stems. Cylinder lubricants should be admitted on the intake side of valves. In the case of turbines, where there may be objection to admitting grease into steam cylinders, valve stems can be lubricated by admitting the lubricant directly on them in quantities just sufficient for the purpose. In no case should a valve stem point in a line that drops below the horizontal; preferably it should point above the horizontal. When a valve closes with a rotating movement and is actuated through a self-packing shaft, there is but little if any need for a lubricant, as the area of friction surface is small and the actuating force for revolving the shaft is highly compounded.

Flyball-Governor Form of Stop

Flyball governors for tripping a latch or breaking a circuit are so sensitive to the force that actuates them that they can be set to trip with a very small increase of acceleration, and a drive for governors can be supplied that is reliable. With reliable drive no condition can arise that will prevent a properly constructed flyball governor from performing its office. Breaking of the drive will allow the governor to swing on its mast and trip the latch. Governors, like pins that project from the rims of flywheels, should be frequently inspected, but unlike pins they are always accessible for inspection regardless of whether or not an engine is running. They can suffer considerable deterioration and yet be efficient, but there should be no excuse for serious impairment of their parts so that a failure might occur that would unnecessarily stop an engine.

Without attempting to go deeply into discussion of the various kinds of stops operated entirely independent of electric current, it may be said that they require the secondary force, which may be brought into action through an initial force, to be considerable, and possibly this may be interfered with. Quoting one prominent maker, "The mechanical is the simplest of our make of engine stops; it is, however, limited as to its possibilities and its use is ordinarily recommended when it is desired to obtain protection from overspeed only, or to shut down the engine by hand from a point no great distance from the engine." The principles involved in an electrically operated engine stop are well-known. The force required for breaking a circuit is insignificant and can be depended on to operate when it should. When the current has been broken the force of gravity, an ever dependable agency, will perform the further office of bringing a stop into action. If any objections raised against one or the other of the two systems can be sustained, the logical solution of the matter would be to install stops that contain a combination of both principles, as is done by some makers and can be done by all of them. The additional cost for installing the combination of methods should be so small as to be inconsiderable and it cannot add complexity without compensation. The method could claim preference because of its wider adaptability, namely, operating by breaking the circuit from a limitless number of stations, and operating because of disarrangement of engine parts or by breakage of them, etc.

Automatic Control a Desirable Feature

Hand-operated quick-closing valves with omission of the automatic-control feature have been installed in some cases. With the exception perhaps of blast engines alone, the omission is not justified since the efficiency of the automatic-control feature has been fully demonstrated. While a hand-

*Abstract of a paper presented at the twelfth annual convention of the Association of Iron and Steel Electrical Engineers, at Baltimore, September, 1918.

operated quick-closing valve permits an operator to shut steam off instantly, he cannot always be depended on to be close enough to a station, or he may decide to get farther away. Even though it might be thought advisable to install hand-operated quick-closing valves on blast engines to check the speed within safe limits if necessary—a case where bringing an engine to a full stop is a hazard too great to be permitted—there could be no objections to adding the auxiliary agency of electric current, as this gives superior advantages through ability to locate stations in the most desirable places regardless of distance or elevation.

In the installation of stops electrically operated entirely, or with electrical operation for an auxiliary to mechanically operated stops, the matter of using open or closed circuits is one of importance. As the supreme principle involved is that a stop must perform its office regardless of other results, the installation cannot be positive unless the fact that the engine is running is evidence that the automatic stopping equipment is in perfect condition. Quoting dfferent makers of engine stops one firm says, "In many ways the closed-circuit system is ideal, in that the fact that the engine is running is a guarantee that the electrical system and engine stop are in perfect condition." Another maker says, "It is a well-known fact that the most reliable electric engine stops are those operated on the closed-circuit principle, for the reason that they are self-testing, and any derangement of the wiring system will cause them to operate and shut off steam from the engine." We have seen installations of closed-circuit systems in mills where they gave perfect satisfaction, and in other mills where the conditions were exactly the same, open-circuit systems were installed. If the closed-circuit system was feasible with some it should have been feasible with all. There is much argument that can be offered in favor of the open-circuit system, yet important questions are not entirely settled by argument alone.

The ideas contained in this paper are either borrowed from the experience of other persons or came within the author's observation. We seek to harmonize ideas on an important matter and reduce them to a common and practical basis. The deductions that could be drawn from the paper are: Automatic engine stops are indispensable adjuncts to all kinds of engines that can overspeed and cause wrecks or accidents. They are dependable when carefully installed and carefully maintained. Their use probably can be extended to include blast engines, and to the performance of various other offices where they would prevent wrecks. Of several types of installation, any can be relied on to act when required if they are properly constructed and reasonable effort is made to maintain them.

In making an installation, consideration should be given to those features that manifestly are the most dependable and will require the least expenditure of care. This in no manner absolves from watchfulness and necessary care.

Conclusions from investigation along theoretical lines have been backed by results in practice and all point to an installation that might be classed as ideal, containing the following important features: The valve for shutting off steam should be rigidly fixed to a shaft that would close the valve when rotated; the actuating force for closing should be gravity with the aid of the current of steam flowing into the cylinder. The static force, which when released actuates the valve, should be released by opening a confining lock; and the static force, which when released opens the lock, should be gravity and released by breaking a feeding circuit for energizing a magnetic coil. Centrifugal force should be the actuating agency for releasing the lock by direct application or by breaking the circuit that energizes a magnetic coil, permitting gravity to open it. The agency actuated by centrifugal force could be either a flyball governor, adjusted by a spring or gravity to speed requirements, or a contact pin adjusted by a spring.

Increased Storage Authorized

Increased storage of bituminous coal by consumers was authorized Oct. 17 in regulations issued by the United States Fuel Administration.

All classes of consumers, except Class 1, as defined by the War Industries Board, were authorized to increase their reserve stocks, and those heretofore not on the preference list were authorized to lay in additional reserve supplies. Consumers in Class 2 may store their coal up to the limits now imposed on Class 1. Consumers heretofore in Class 3 will receive the facilities heretofore accorded to Class 2, and consumers in Class 4 have been allotted the opportunities heretofore reserved for Class 3. Consumers now on the preference list are allowed the stocks formerly permitted Class 4 concerns.

The regulations, it was announced, will stand until further notice, and it was stated that, under them, an opportunity is afforded every industrial consumer for laying in at this time some reserve supply of bituminous coal.

Regulations in detail are as follows:

Consumers in Classes 1 and 2: Maine, 135 days; Massachusetts, Vermont, New Hampshire, northern New York, 105 days; Connecticut, Rhode Island, southwestern New York, 90 days; southeastern New York and New Jersey, 60 days; Delaware, eastern Pennsylvania, Maryland, District of Columbia, Virginia, North Carolina, South Carolina, Georgia, Florida and western Ohio, 45 days; western Pennsylvania, West Virginia, eastern Kentucky, eastern Ohio, 35 days; Lower Michigan, 90 days.

Consumers in Class 3: Maine, 120 days; Massachusetts, Vermont, New Hampshire, northern New York, 90 days; Connecticut, Rhode Island, southwestern New York, 75 days; southeastern New York and New Jersey, 50 days; Delaware, eastern Pennsylvania, Maryland, District of Columbia, Virginia, North Carolina, South Carolina, Georgia, Florida, western Ohio, 40 days; western Pennsylvania, West Virginia, eastern Kentucky, eastern Ohio, 30 days; Lower Michigan, 75 days.

Consumers in Class 4: Maine, 105 days; Massachusetts, Vermont, New Hampshire, northern New York, 75 days; Connecticut, Rhode Island, southwestern New York, 60 days; southeastern New York and New Jersey, 40 days; Delaware, eastern Pennsylvania, Maryland, District of Columbia, North Carolina, South Carolina, Georgia, Virginia, Florida, western Ohio, 35 days; western Pennsylvania, West Virginia, eastern Kentucky, eastern Ohio, 25 days; Lower Michigan, 60 days.

Consumers not on the preference list are limited to the following stocks: Maine, 90 days; Massachusetts, Vermont, New Hampshire, northern New York, 60 days; Connecticut, Rhode Island, southwestern New York, 45 days; southeastern New York and New Jersey, 30 days; Delaware, eastern Pennsylvania, Maryland, District of Columbia, Virginia, North Carolina, South Carolina, Georgia, Florida, western Ohio, 30 days; western Pennsylvania, West Virginia, eastern Kentucky, eastern Ohio, 20 days; Lower Michigan, 45 days.

There is no restriction on the stocks of screenings which may be accumulated by either preference or nonpreference consumers, nor is there any restriction on the stocks of Indiana, Illinois or Western coal which consumers in any class may obtain. Supervision of the accumulation of stocks in accordance with these limits will be exercised by the several state fuel administrators who are authorized to make exceptions where special conditions make it necessary.

Shipping Board Wants 2000 Firemen at Once for Merchant Marine

Chairman Edward N. Hurley of the United States Shipping Board stated Oct. 22 that 2000 firemen are wanted by the board at once to make good a deficiency in the normal supply of volunteers for this service caused by influenza. "Men feeding the fires of our merchant ships in these times are in our first line of defense," said Mr. Hurley. "The service is vital to our 'bridge of ships' and our sea-borne commerce."

Orders were sent to the board's 6854 drug-store recruiting stations to speed up the enrollment of men from 18 to 35 inclusive, weighing at least 140 pounds, who will serve as firemen. These volunteers will be sent from their home towns to Boston, New Orleans, San Francisco, Seattle or Cleveland at Government expense, for 30 days' special drill on the board's training ships before being shipped out on deep-water voyages.

Merchant marine firemen now earn $75 a month and their keep, with 50 per cent. added for war-zone voyages.

New Publications

STEEL SHIPBUILDER'S HANDBOOK. By C. W. Cook. Published by Longmans, Green & Co., Fourth Ave. and 36th St., New York City; London, 39 Paternoster Row. Flexible cover, 4½ x 7 in.; 123 pages; 4 plate illustrations. Price, $1.50.

This handbook has been published and compiled for the purpose of assisting workmen in the shipyards to understand the names of the parts, tools, operations, trade abbreviations, etc., used in the building of steel ships. The author has made a study of the latest and best methods used in the large shipbuilding plants all over the country and of the best textbooks on steel shipbuilding. The book is printed in such size and shape as to make it possible to carry it in the pocket, so that whenever a new name or word is encountered in the work, it can be looked up without delay. About 1600 names are defined, and about 200 parts are illustrated.

MINERAL OIL TABLES. By E. N. Hurlbert. Published by Taylor Instrument Co.'s, Rochester, N. Y. Cloth, 4½ x 6½ in. 204 pp. Price, $1.

This volume is a collection of tables that are intended to give those interested in the testing and refining of mineral oils a handbook of authoritative information. Over thirty tables covering temperature corrections for gravity reading, corresponding gravity and weight, and similar testing data, also for steam and refrigeration plant operation, conversion of weights, measures and moneys, etc., have been incorporated. There have been included not only tables for use in testing and inspection of oils, but also those relating to general refinery practice. The majority of the tables have been copied from circulars of the Bureau of Standards. Others have been obtained from the most authoritative sources possible.

FUEL ECONOMY IN BOILER ROOMS. By Maujer and Bromley. Cloth; 6 x 8¼ in.; 308 pages; illustrated. New York City. Published by McGraw-Hill Book Co., Inc. Price, $2.25.

"Fuel Economy and CO_2 Recorders" filled the needs of the student and engineer interested particularly in the theoretical side of the boiler room. It dealt well with the principles of combustion, coal analysis, flue-gas analysis and the calculations involved in determining boiler efficiency, etc. It needed considerable on the practical side of boiler-room operation to round it out into a work that the power-plant man would want at hand, especially in these days when fuel saving is so vital. The book has therefore been extended to include fuels, firing methods, combustion of coal from the practical standpoint, fuel-oil burning, operation of stokers, boiler settings, burning low-grade coal and waste gases. Ready means of checking the boiler efficiency also are treated of. The new matter, of which there is considerable though thinner pages throughout has not greatly increased the weight of the volume, was prepared by Mr. Bromley. The book, "Fuel Economy in Boiler Rooms" meets an urgent need.

WATER RIGHTS DETERMINATION. By Jay M. Whitham. Published by John Wiley & Sons, Inc., New York. Cloth; 6 x 9 in.; 204 pages. Price, $2.50.

A hundred years or more ago, water-power grants were very loosely worded. In some instances rights were sold for the operation of a specified number of machines of a class, but it was more common to find no restrictions whatever. Thus, many grants were sold with a simple allusion to the nature of the industry, as, a sawmill, a machine shop, a nail works or a tannery. If the owner of such rights should wish to determine just what he was entitled to use, he would have to interpret the terms of the grant in the light of the state of water-power development and use at the time the grant was made. This book is written specifically for the owner of an indefinite water right and is intended to enable him to determine the meaning of his right as expressed in horsepowers and the number of cubic feet of water per second to which he is entitled. It is based on the author's twenty-seven years of experience in interpreting such grants, as well as an exhaustive study of all available books on milling, millwrighting, tanning, sawmills, rolling mills, blast furnaces, waterwheels, etc. It takes up the subject according to the various industries and contains a large amount of data on the power required to drive various classes of machinery. A bibliography of the subject concludes the work.

STEAM TURBINES. By G. J. Meyers, Lieutenant Commander, U. S. N. Cloth, 12 x 8 in.; 246 pages; illustrated. Published by the United States Naval Institute, Annapolis, Md. Price, $4.50.

The book has been prepared to meet the needs of an elementary treatise on steam turbines for use of midshipmen of the United States Naval Academy. The text deals, therefore, almost exclusively with types of turbines found in the U. S. Navy. There are seventeen chapters and all except one are confined to turbines. Condensers, air pumps, etc., are given consideration in chapter VII. An appendix relates to the decision of the United States Circuit Court of Appeals in the case of the International Curtis Marine Turbine Co. and the Curtis Marine Turbine Co. of the United States vs. William Cramp & Sons Ship and Engine Building Co. The volume is profusely illustrated, there being 161 illustrations, most of them inserts on fine quality paper and each figure number carrying many illustrations. It is the best-illustrated book on turbines that has yet appeared, and for the purpose intended admirably fills all needs. The volume should have wide use as our navy and merchant marine must become larger and larger.

Personals

James B. Harvey, who for a number of years has been general manager of the Public Service Co., York, Neb., has recently been elected vice president of the Continental Gas and Electric Corp. and placed in active charge of the company's properties in Iowa and Nebraska, with headquarters in Omaha, Neb.

Frank H. Brooks, formerly manager of the Lincoln, (Neb.) Traction Co., member of the firm of Mid-West Electric Co. of Omaha, Neb., and general manager of several Iowa public utilities, has recently been appointed general manager in charge of operation of the Continental Gas and Electric Corporation's properties in Iowa and Nebraska, with headquarters at Omaha.

George E. Hall, formerly vice president and general manager of the Boston Woven Hose and Rubber Co., has been elected president and general manager, succeeding Henry B. Sprague, treasurer, who has served as president pending the annual election. Mr. Sprague continues as treasurer and assumes the additional duties of the vice president. Mr. Hall has been associated with the company for eleven years, having taken charge in July, 1907, as general manager.

Wilson S. Kinnear has been appointed personal representative of the Fuel Administration in coöperation with the Anthracite Committee. Mr. Kinnear is head of the firm of W. S. Kinnear & Co., consulting engineers, and was formerly president of the United States Realty and Improvement Co. Before establishing himself in New York, he was president of the Kansas City Terminal Co. While chief engineer of the Michigan Central R. R. Co., he had charge of the construction of the railroad tunnel under the Detroit River.

Engineering Affairs

The American Society of Mechanical Engineers announces the postponement, indefinitely, of the meeting of the Council and the Mid-Western sections of the society, scheduled for Oct. 25-26 at Indianapolis, Ind., on account of the epidemic.

Business Items

The Whitlock Coil Pipe Co., of Hartford, Conn., has opened an office in Boston at 50 Congress St., under the management of W. B. Hoyt, its former Rochester representative.

The Bowers Rubber Works, of San Francisco through its Eastern representative, W. L. Rogers, announces that the distribution of its "Skookum" packing for New York City and immediate vicinity is now in the hands of the New Jersey Asbestos Co., New York City.

The Underfeed Stoker Co. of America has opened a district sales office in Cleveland in charge of H. F. Post, who formerly was connected with the home office at Chicago. S. A. Williamson, formerly in charge of the Cincinnati office, will take charge of the newly established Minneapolis office, and G. W. Bonnell will take charge of the St. Louis office.

New Construction

PROPOSED WORK

Mass., Worcester—The Rockwood Sprinkler Co., 141 Milk St., Boston, plans to build a brick boiler house here.

N. Y., New York—T. F. Hussa, 50 Church St., is in the market for a 10-ton locomotive crane, 8 ft. gage, and a 150-hp. Scotch marine boiler.

N. Y., New York—The Visayan Refining Co., 50 Broad St., is in the market for one 3 or 4 ft. full universal radial drill, motor drive.

Penn., Cheswick—The Duquesne Light Co., Chamber of Commerce Bldg. plans to build a power house. Estimated cost, $15,000,000. Ford, Bowen & Davis, Chamber of Commerce Bldg., Engr.

Va., Norfolk—The Virginia Railway & Power Co. plans to install two boiler units to increase the capacity of its power plant. J. P. Keeney, Ch. Engr.

W. Va., Huntington—The H. T. Lambert Co., Box 346, is in the market for a steam locomotive; 5 to 7 tons gage, in good condition.

Ga., Atlanta—E. C. Butner, 1019 Empire Bldg., is in the market for 500, 750, 1000 and 1500 g.p.m. steam driven underwriters fire pumps, first class working order prompt delivery.

Ga., Waverly Hall—Pitts & Frizzell is in the market for a good second-hand 40-hp. crude oil engine; Meitz & Weiss preferred.

Fla., Jacksonville—The city will soon award the contract for installing reciprocating air compressors belted to 50-hp. 2200 volt, 60 cycle, induction motor, compressor to travel not more than 200 r.p.m. and deliver 350 cu.ft. per minute at 100 lb. pressure. L. E. Murphy, Engineers Building, Engr.

Tenn., Chattanooga—M. B. Parker, 1912 Oak St., is in the market for a second-hand 150-hp. slip-ring motor.

Tenn., Knoxville—John G. Duncan, 308 West Jackson Ave., is in the market for a single and duplex second-hand steam pump, in first-class working order, 2-in. discharge through 2400 ft. pipe, 150 head.

Ohio, Ashland—The Central Steel Co. is in the market for a 300 to 700-lb. power hammer.

Ohio, Barberton—Babcox & Wilcox is having plans prepared by F. L. Harzog, Engr., c/o owner, for the installation of a steam heating system through its entire factory, and is in the market for high pressure piping, motors, fans, blowers, etc. Total estimated cost, $75,000.

Ohio, Cleveland—The Board of Education will install a steam heating system in the proposed 3-story normal school on Euclid Ave. and 109th St. Total estimated cost, $100,000. W. R. McCormack, East 6th St. & Rockwell Ave., Arch.

Ohio, Springfield—The Edwards Motor Co. is in the market for a small engine with B-2 priority.

Ind., Indianapolis—The Ross Power Equipment Co., Merchants Bank Bldg., is in the market for two 500-hp., 160-175 lb. boilers; 100-200 k.w., 240-480 volt, 60-cycle, 3-phase engine set; 500-1000 g.p.m. boiler-feed pump; 100 k.w., 175-volt, turbine-driven, non condenser exciter unit; 100-180 hp. gas engine.

Mich., Lansing—The city has taken over the plant of the Michigan Power Co. and plans to erect a new unit and install new equipment. Estimated cost, between $150,000 and $200,000.

Wis., Milwaukee—The Milwaukee Steel Foundry Co., 101 South Water St., plans to install a 3-ton electric furnace in its plant.

Wis., Sheboygan—The Standard Oil Co., 1209 Pennsylvania Ave., plans to build an engine house, loading platform, etc., for its Sheboygan branch and distributing station.

Iowa, Iowa Falls—The Ohio Gas Co. plans to reconstruct its gas plant which was totally destroyed by fire.

Minn., Janesville—City soon lets contract for building and installing 2-stroke pump head directly connected to a 20-hp. slip ring motor, 220-volt, 60 cycle, 3-phase a.c. pump capable of delivering 200 gal. per minute against total head of 200 ft. drop, pipe to be 8-in. standard weight, galvanized. R. R. Brown, Recorder.

Minn., St. Paul—The St. Paul Union Depot Co., foot of Sibley St., will soon award the contract for the installation of a steam heating system in the 1-story, 150 x 300 ft. depot which it will build on Wacouta and 3rd St. Total estimated cost, $1,000,000. W. C. Frost, 321 Capital Bank Bldg., Engr.

Okla., Tulsa—The Independent Packing Co., 25 East 12th St., is in the market for refrigerating machinery and engine, for the new building which it plans to erect. Uley Holderman, Mgr.

Okla., Tulsa—H. A. Pressey, Hotel Tulsa, is in the market for two 250-h.p. water tube boilers, 1 boiler feed water heater, 2 boiler feed water pumps, 1 CO_2 machine, 2 boiler feed regulators, 2 250-hp. directly connected to 300-k.w. generators, 1 panel switchboard, 1 steam turbine directly connected to centrifugal pump, also all appurtenances to complete power house.

Sask., Moosejaw—George D. Mackie, Engr., is preparing plans for extensions to the waterworks; pumping equipment, mains, etc., will be installed in same. Total estimated cost, $125,000.

CONTRACTS AWARDED

Mass., West Dudley—The Burmus Paper Co. has awarded the contract for the construction of a 1-story, 30 x 52 ft. concrete and brick hydro-electric power plant with concrete dam 150 ft. long on one side and 250 ft. earth dike on other, to T. F. McGovern, Southbridge. Estimated cost, $55,000. Contract for three 30-in. vertical turbines which under 13 ft. head will develop 190-hp. each; to be directly connected to three 165 k.v.a., awarded to James Leffel & Co., Lagonda Ave. Generators to be supplied by the Electric Machinery Co., 102 Pearl St., Boston.

R. I., Coddington Point—The Bureau of Yards & Docks, Navy Department, Wash., D. C., has awarded the contract for the installation of heating, cold storage and refrigeration systems, to the General Heating & Ventilating Co., 198 Milwaukee St., Milwaukee, Wis. Estimated cost, $1,164,350.

N. Y., Blackwells Island—F. L. Dowling, Pres. of Manhattan Borough, received low bids for installing extra set of 2300-volt bus bars and replacing existing set; also installing additional panels, switches, buses, etc., and changing gallery in substation of Blackwell's Island, from T. Frederick Jackson, Inc., 99 John St., New York City, $9900, and Jandous Electric Equipment Co., Inc., 109 West 31st St., New York City, $15,840. Noted Oct. 15.

N. Y., Endicott—The International Time Recording Co. has awarded the contract for the construction of a 1-story, 20 x 30 ft. extension to its power plant, to Westinghouse, Church, Kerr, 37 Wall St., New York City. Estimated cost, $50,000.

Penn., Neville Island—The United States Housing Corp., Department of Labor, has awarded the contract for the construction of a temporary boiler house here, to the Rodd Co., Century Building, Pittsburgh.

N. Y., Syracuse—The New York Central R. R., has awarded the contract for the construction of an engine house, to the Ballard Construction Co. Estimated cost, $250,000. G. W. Kittridge, Ch. Engr.

Penn., Milton—The Milton Manufacturing Co. has awarded the contract for the construction of a 28 x 110 ft. and 46 x 68 ft. power house, to Sources & Moore. Noted Oct. 1.

Md., Baltimore—The Bartlett, Haywood Co., Scott and McHenry St., has awarded the contract for the construction of a 47 x 54 ft. steel and concrete boiler house for its munition plant on Columbia Ave. and Putnam St., to Morrow Bros., Fidelity Bldg. Estimated cost, $15,500.

Md., Monkton—The Monkton Roller Mills has awarded the contract for the installation of a hydro-electric plant in the roller mill plant which it will build, to E. H. Mosher, 427 Munsey Bldg. Estimated cost, $30,000.

N. C., Mount Airy—The City Commissioners have awarded the contract for the construction of a 1-story, 24 x 30 ft. power plant, to M. E. Jones. Estimated cost, $30,000. Noted Oct. 8.

Ohio, Cincinnati — The Dixie Terminal Co., Union Central Life Bldg., has awarded the contract for the installation of a steam heating system in the 4-story, 180-200 ft. office and terminal building which it will erect on 3rd St., to M. H. Crane Estate, 326 West Pearl St. Contract for the installation of boilers awarded to Heine Safety Boiler Co., 1432 Union Trust Bldg.

Ohio, Cleveland—The Cleveland Welding Co., 2129 West 117th St., has awarded the contract for the construction of a 1-story, 80 x 100 ft. power house, to Hunkin-Conkey Construction Co., 601 Century Bldg. Estimated cost, $25,000.

Cal., Coalinga—The city has awarded the contract for the installation of a heating and ventilation system in the high-school, to J. C. Hurley, 509-6th St., San Francisco. Estimated cost, $17,898.

WASHINGTON, D. C.

The Bureau of Supplies & Accounts, Navy Department, will soon receive bids for furnishing under Schedule No. 6695½, 1 locomotive and 1 motor generator, delivery Philadelphia, Penn.

The Bureau of Supplies & Accounts, Navy Department, will receive bids for furnishing equipment as follows::

Nov 1, Schedule No. 6548½, 1 power press, delivery Washington, D. C.

Nov. 1, Schedule No. 6658½, miscellaneous engine generators, delivery Cape May, N. J.

Nov. 8, Schedule No. 6620½, 4 air compressors, delivery Alexandria, Va.

Bids were received by the Bureau of Supplies & Accounts, Navy Department, for furnishing equipment as follows:

Schedule No. 5935½, Class 1505, engine lathe, delivery Portsmouth, N. H., from Dale-Brewster Machinery Co., 30 Church St., New York City, N. Y., $1281, alternate $1365, alternate $1652; Kemp Machinery Co., 223 North Calvert St., Baltimore, Md., $1104; Lynd-Farquhar Co., 419 Atlantic Ave., Boston, Mass., $1445; Monarch Machine Co., Sidney, Ohio, $845; D. Nast Machinery Co., Bourse Bldg., Philadelphia, Penn., $878; Niles Bement & Pond Co., 111 Broadway, New York City, N. Y., $1115; Henry Prentiss & Co., 149 Broadway, New York City, N. Y., $1180; Patterson Gottfried & Hunter Co., $1355; Whitcomb-Blaisdell Machine Tool Co., 134 Gold St., Worcester, Mass., $1447; Cincinnati Lathe & Tool Co., Cincinnati, Ohio, $1080; Fairbanks Co., Colorado Bldg., Wash., D. C., $1274, alternate $961; Wm. F. Davis Machine Tool Co., 945 Pennsylvania Ave., Wash., D. C., $995; Manning, Maxwell & Moore, 119 West 40th St., New York City, N. Y., $1451.

Schedule No. 6268½, Class 1492, engine lathes, delivery Brooklyn, N. Y., from Fairbanks Co., Colorado Bldg., Wash., D. C., $2180; Manning, Maxwell & Moore, 119 West 40th St., New York City, N. Y., $1980; Niles-Bement & Pond, 111 Broadway, New York City, N. Y., $2320; D. Nast Machinery Co., Bourse Bldg. Philadelphia, Penn., $1570; Henry Prentiss Manufacturing Co., 149 Broadway, New York City, N. Y., $2499; Dale Brewster Machine Co., 30 Church St., New York City, N. Y., $1651.

Schedule No. 6292½, Class 1539, pneumatic drills, delivery Boston, Mass.; from Chicago Pneumatic Tool Co., 343 South Dearborn St., Chicago, Ill., $110; Ingersoll Rand Co., 11 Broadway, New York City, N. Y., $99; Independent Tool Co., 1307 Michigan Ave., Chicago, Ill., $100.

Schedule No. 6316½, Class 1583, five motors, delivery Brooklyn, N. Y., from Allis Chalmers Manufacturing Co., Clinton St., Milwaukee, Wis., $1793; Crocker Wheeler Co., Ampere, N. J., $2370; Century Electric Co., 19th and Pine St., St. Louis, Mo., $1110; O. O. Hall, 147 West 35th St., New York City, N. Y., $1839; Ideal Electric and Manufacturing Co., 153 East 5th St., Mansfield, Ohio, $1791; Lincoln Electric Co., 38th St. and Kelley Ave., Cleveland, Ohio, $1823; Mechanical Appliance Co., 133 Stewart St., Milwaukee, Wis., $916; Northwestern Manufacturing Co., 480 Clinton St., Milwaukee, Wis., $1730; Robbins & Meyers Co., Lagonda and Farlow St., Springfield, Ohio, $422; Triumph Electric Co., South St., Cincinnati, Ohio, $1784; Wagner Electric Co., 6400 Plymouth St., St. Louis, Mo., $1660; B. A. West Electric Co., Cincinnati, Ohio, $1808; Westinghouse Electric & Manufacturing Co., Hibbs Bldg., Wash., D. C., $1668; Fairbanks Morse & Co., Colorado Bldg., Baltimore, Md., $1992.

Schedule No. 6380½, Class 1657, one 5-hp. motor, delivery Norfolk, Va., from Allis-Chalmers Manufacturing Co., Clinton St., Milwaukee, Wis., $270; Crocker-Wheeler Co., Ampere, N. J., $412; Century Electric Co., 19th and Pine St., St. Louis, Mo., $214; Fidelity Electric Co., 331 Arch St., Lancaster, Penn., $489; Ideal Electric & Manufacturing Co., 153 East 5th St., Mansfield, Ohio, $285; Mechanical Appliance Co., 133 Stewart St., Milwaukee, Wis., $253; Northwestern Manufacturing Co., 480 Clinton St., Milwaukee, Wis., $267; Robbins & Meyers Co., 331 North Arch St., Springfield, Ohio, $248; Triumph Electric Co., South St., Cincinnati, Ohio, $302; Wagner Electric Co., 6400 Plymouth St., St. Louis, Mo., $271; Fairbanks Morse Co., Colorado Bldg., Baltimore, Md., $305.

Schedule No. 6410½ Class 1687, arc welding motor, delivery Philadelphia, Penn., from Lincoln Electric Co., 38th St. and Kelley Ave., Cleveland, Ohio, $36,000; W. E. Tuttle, Jr., Garwood, N. J., $33,600; Westinghouse Electric and Manufacturing Co., Hibbs Bldg., Wash., D. C., $30,624; Belts & Belts Corporation, Chicago, Ill., $42,634.

THE COAL MARKET

Boston—Current quotations per gross ton f.o.b. mines are as follows:

ANTHRACITE

	Circular Current		Circular Current
Buckwheat	$3.40	Boiler	$2.65
Rice	2.90	Barley	2.40

All-rail rate to Boston is $2.86.

BITUMINOUS

Bituminous, $8 to $8.75.

Pocahontas and New River, f.o.b. Boston, $8.35 to $8.90.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

	Circular	Individual		Circular	Individual
Pea	$5.50	$6.25	Broken	$6.75	$7.50
Buck.	5.10	5.90	Egg	6.65	7.40
Rice	4.65	5.10	Stove	6.90	7.65
Barley	4.15	4.30	Chestnut	7.00	7.75

BITUMINOUS

Current quotations, gross tons, based on Government prices at the mines, net ton; f.o.b. Tidewater, at the lower ports, are as follows:

	Mine Gross	F.O.B. N.Y. Gross
Central Pennsylvania (Mine run, Prepared or Slack)	$3.30	$5.45
Upper Potomac, Cumberland & Piedmont Fields:		
Run of Mine	3.08	5.23
Prepared	3.36	5.51
Slack	2.80	4.95

Quotations at the upper ports for both bituminous and anthracite are 5c. higher on account of the difference in freight rates, and are exclusive of the 3% war freight tax.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Current	One Yr. Ago	Current	One Yr. Ago
Pea	$3.75	$5.00	$4.60	$4.00
Barley	2.40	1.90	3.30	2.15
Buckwheat	3.40	2.90	4.45	3.80
Rice	2.90	2.40	3.80	3.40
Boiler	2.70	2.20	3.70	3.30

Chicago—Steam coal prices f.o.b. mines:

	Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.55—2.70		$3.25—3.40
Mine-run	2.35—2.50		3.00—3.15
Screenings	2.05—2.20		2.75—2.90

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared Sizes	Slack or Screenings
Big Seam, Mary Lee, New Castle, Blue Creek, Brookdale, Milldale, Henry Ellen or Acmar	$2.45	$2.75	$2.40
Cahaba, Black Creek, Milldale, Carter and Durie seams, and Underwood seam in Etowah and Blount Counties, Jefferson seam in Marion, Walker and Winston Counties	3.45	3.75	3.10
Pratt, Brookwood, Nickel Plate, America, Jagger, Coal City, Jefferson (except in Walker, Marion and Winston Counties), Mt. Carmel seam or upper branch of Big Seam on Birmingham Mineral south of Bessemer	2.85	3.05	2.45
Helena and Harkness seams and coal mined by No. 2 Belle Helen, and Youngblood seam	2.90	3.20	2.70
Climax seam near Maylene,			

St. Louis—Prices per net ton bituminous coal f.o.b. mine today as compared with a year ago are as follows:

	Williamson and Franklin Counties, Mt. Olive and Staunton	Standard
Prepared sizes (lump, egg, nut, etc.)	$2.55@2.75	$2.40@2.70
Mine-run	2.35@2.50	2.20@2.30
Screenings	2.17@2.32	1.50@1.50

Williamson-Franklin rate to St. Louis is $1.10.

other rates p. 95.